

OBJECT LESSONS  
IN BOTANY  
FROM FOREST, FIELD AND GARDEN.  
BOOK II.

BY E. S. NELGROVE, B.A.

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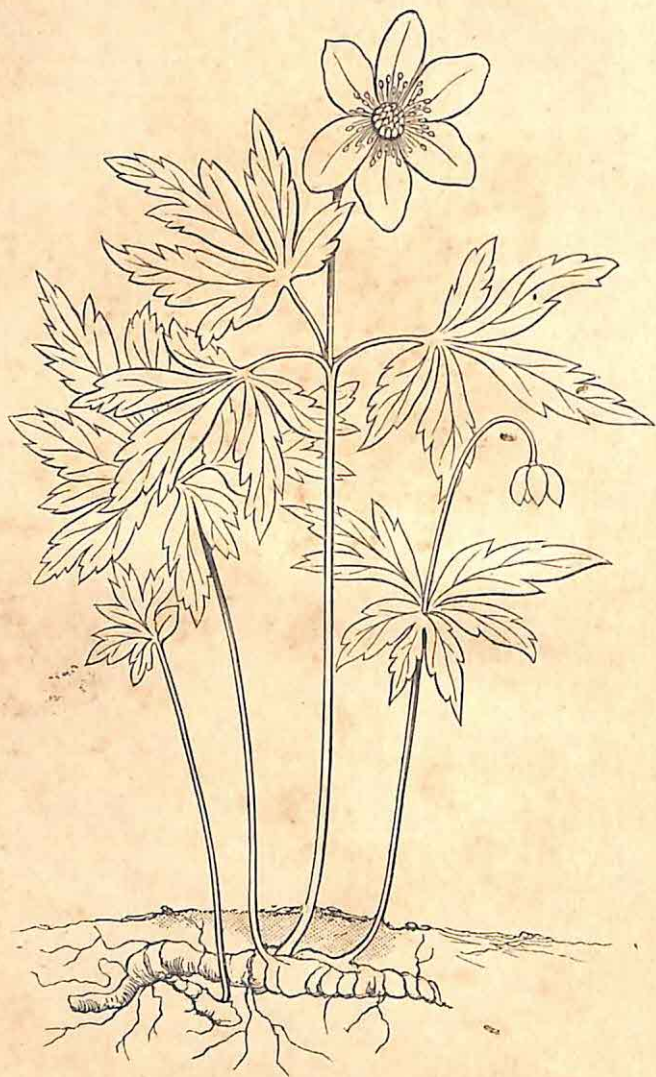
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# OBJECT LESSONS IN BOTANY

FROM

Forest, Field, Wayside, & Garden.

(BOOK II. FOR STANDARDS III., IV., & V.)

*Being a Teachers' Aid to a Systematic Course of One Hundred  
Lessons for Boys and Girls.*

BY

EDWARD SNELGROVE, B.A.

FOURTH EDITION.

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## PREFACE.

In the review column of a recent issue of *Natural Science* the following passage occurs :—

“Whether education or mere instruction be its aim, that book is most likely to succeed that leads its readers along the same paths as the discoverers of the science must themselves have followed. Students should not have facts thrust at them, but should be shown how to find them out; steps should be made, not simply taken; conclusions should be drawn, not merely stated; definitions should be led up to and not started from.”

These ideals here so clearly expressed have been before me in planning out the one hundred lessons which make up this little book. How far I have been able to realise them is a question that must be left for others to decide.

I have endeavoured to adhere to the principles followed in the first or introductory part of this work, which, a year ago, met with a most encouraging reception, both from teachers and from the educational and general press.

The lessons are intended for children from nine to eleven years of age, and observation has, therefore, been restricted to those aspects of the subject which may fairly be considered to lie within the scope of their capacities—the study of internal structures and functions requiring microscopic investigation being deferred so as to form a third part, comprising a more

advanced course. Although, however, it is hoped the book will be found to have a unity and completeness in itself, yet no attempt has been made to deal with the subject exhaustively, or even to supersede any existing text book. On the contrary, it may rather be urged that little students having received the preparation afforded by these lessons, will then be ready to take up some of the elementary courses which have hitherto been entered upon without any such introduction, or, perhaps, more frequently avoided for want of one.

Technical terms have been sparingly, cautiously, and gradually introduced. To plunge the young learner into a sea of technicalities (as the custom of only too many books is), is to disgust him with what should be a most fascinating and useful study; to avoid them, on the other hand, is to lose a very important training in exact thinking and correct expression afforded by the copious and precise vocabulary for which this branch of Natural Science is, by some, ignorantly derided, but by others, more justly, esteemed. My object, therefore, has never been the mere avoidance of terms, but the judicious introduction and use of them; no term being admitted into a lesson until that for which it stands is comprehended. Some few additional terms not occurring in the lessons have been added under the illustrations, in brackets, or in the Appendix, so that they may be taken or left at will, or simply used for reference.

The illustrations have not been prepared as substitutes for actual specimens, but only as guides to help in showing what is needed or what should be looked for.

The Fourth Section, which is supplementary to the third, deals with classification, and may be taken either where it is placed or



immediately after the second section. The tables are given for reference, so that a more or less extended use may be made of this interesting part of the work. Certainly, the last thing to be dreamt of, should be the learning of the tables by heart.

As a result of practical experience I would add that each lesson should be mastered before the next is proceeded with; if one is not grasped, it should be repeated with the same or similar specimens until the points to be brought out have become familiar. In this way, a repetition of the lessons after the course is completed, becomes altogether unnecessary, and is contrary to the spirit in which the lessons have been worked out. And if I may make a suggestion on the testing or examination of this subject, I would say, first, that whatever questions be applied they should only seek to ascertain how far general conclusions have been arrived at, and the grounds on which they have been based; and secondly, that the most important part of an examination should consist of practical work. If a child has placed before him, a specimen, be it leaves, flower, or fruit, and he can accurately examine it and write down all that can be observed about it, he gives evidence of having had no inconsiderable portion of his faculties educated.

\* \* \* \* \*

I am deeply convinced that Botany is pre-eminently the branch of Science most fitted for the young, not only on account of its purely educational value in the development of the faculties, its utilitarian value in the parallel it affords to animal physiology, its moral and æsthetic value, but also on account of the perennial source of pleasure capable of constant gratification, of which it is the unfailing spring; and if by



putting forth these lessons I have done anything to effectively prove this contention to those who teach and to those who learn, or anything which will lighten the labours of either the one or the other, I shall have been largely rewarded for my efforts.

E. S.

*Heeley,  
Sheffield.*

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### PREFACE TO THE FOURTH EDITION.

THE printing of a new edition has been taken advantage of to make some corrections, introduce new matter, and make several revisions, so as to increase the usefulness of the book. In Section I., Lessons XIV.--XXIII. have been entirely recast, and additional notes on method have been added to pages xviii., 88, and 89.

To several lessons have been appended questions, either as exercises or intended to provoke thought and observation.

Altogether about thirty pages of new matter have been added without sacrificing anything material or of importance. When the book was first issued it was felt that some apology or justification was needed for suggesting to teachers of primary schools that such a subject as Botany should form part of the ordinary curriculum. But educational methods have developed to such an extent during the past ten years, that the author feels under no such necessity now. His present hope is that this revision may have done something to keep the book up to the needs of the time.

E. S.

*Jan., 1906.*

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SECTION I.

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LEAVES, STEMS, AND ROOTS:  
THEIR FORMS AND FUNCTIONS.

## NOTE ON APPARATUS.

---

It cannot be too strongly urged, that by far the most important part of the apparatus for this subject, consists of green specimens, in sufficient quantity for each pupil to have one. The pupils should be encouraged to assist in bringing specimens, and should be shown how to dry and preserve them. Thus a collection of dried specimens would be prepared for winter. Children may easily be led to take a great interest in making collections of leaves, especially if they are shown how to mount them.

Beyond this, little apparatus is needed at this stage; what is further required is indicated at the heads of lessons.

*Drying.* Plants, or leaves of plants, are easily dried by being placed, when fresh, between layers of blotting paper or newspaper. These should be laid between a couple of boards, and pressed by three or four bricks placed on the upper one. Several layers of specimens may be put in at the same time; fresh ones should not be added to half-dried ones; the drying specimens should be kept in a dry place, and the papers should be changed three or four times. In a fortnight they ought to be ready for mounting.



*Mounting.* Sheets of paper, scrap books or drawing books, a very thin solution of glue, and a camel-hair brush are all that are necessary for this purpose. *Gum tragacanth* dissolved in cold water, is much cleaner and easier to manage than glue, but it does not hold the specimens so well.

*Nature Drawings.* After several years' experience and trying different ways of recording observations I have found none so interesting to children or valuable in results as that of making studies of the leaves with pencil and water colour, or with brush alone. At first a little flat tinting or mere washing with one colour is all that is attempted. As the pupils become proficient they are allowed to use natural colours, especially in dealing with Autumn leaves, and all clearly observable details are put in. Drawings of this kind in books are as good to refer back to as the dead leaves.

# OBJECT LESSONS

FROM

Forest, Field, Wayside, and Garden.

---

## LESSON I.

### PARTS OF A LEAF.

*A good supply of leaves (including grass, hawthorn, ivy, currant, lime, apple, and pansy) not detached from the stem on which they grow.*

#### INTRODUCTION.

1. Draw attention to the specimens of leaves, and arouse an interest in them by a few questions on their general known uses, bringing out:—

- (a) Leaves cover the trees with a beautiful mantle, and the ground with a no less beautiful carpet of green.
- (b) They are pleasing to the eye at all times, but especially in their spring freshness, and in the red and gold tints of autumn.
- (c) They afford shelter and shade for man, bird, and beast.
- (d) They supply articles of food, none so much as the grass.

2. But we are going to look at leaves still more closely to try to find out more about them. There are many things we can learn about them if we only *observe* them with sufficient care.

#### TWO PARTS.

1. Distribute specimens to all the pupils. Let each detach one leaf from the stem. Let him hold it as you hold a similar specimen, and handle it in the same way, observing:—

- (a) There are two parts.
- (b) One is broad and flat.
- (c) The other is thin and round—the *stalk*.

2. Now distribute leaves of grass. Let each pupil carefully draw the long pointed leaf between his thumb and finger; lead out:—

- (a) A leaf of grass is long and pointed.
- (b) It is like a sword or knife blade.
- (c) Hence it is called a *blade*.
- (d) The broad part of other leaves is also called a *blade*.

3. Let each pupil strip off carefully the whole of the leaf, noticing:—

- (a) The lower part of a grass leaf enfolds the stem.
- (b) It forms a case or *sheath* enclosing the stem and younger leaves.

4. Summarize—A leaf consists of:—

- (a) A blade and stalk (Fig. 1);
- or (b) A blade and sheath (Fig. 2).

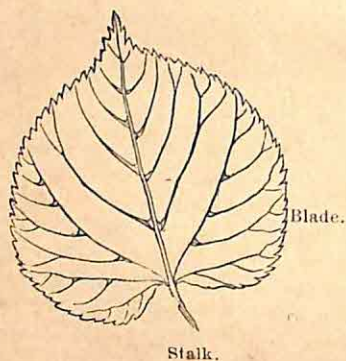


Fig. 1. Leaf of Lime ( $\frac{1}{2}$  natural size).

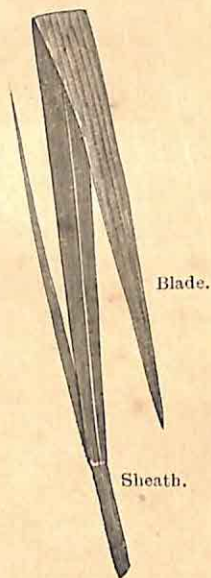


Fig. 2. Leaf of Grass, showing parallel venation of blade and sheath.

## STIPULES.

1. Take some leafy hawthorn twigs and allow each pupil to detach a leaf, carefully pulling downwards and backwards. Two leafy attachments will be noticed at the bottom of the stalk just where it parts from the stem. These are called *stipules*.

2. Examine ivy or currant leaves. They are without stipules.



## SUMMARY.

A leaf may be made up of:—

- (a) Blade and stalk, *e.g.*, ivy, currant, lime, *etc.*;
- or (b) Blade, stalk, and stipules, *e.g.*, hawthorn, pansy, cherry;
- or (c) Blade and sheath, *e.g.*, grass.

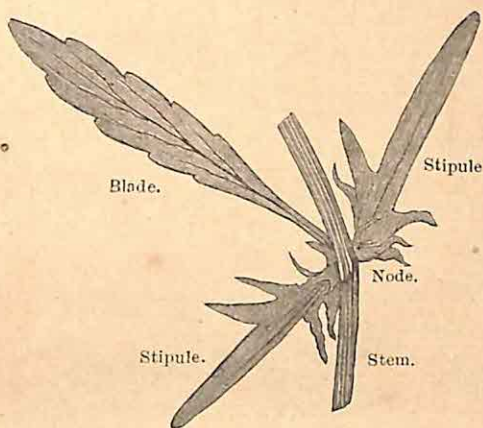


Fig. 8. Stem and leaf of Wild Pansy with large stipules (four-fifths natural size).

## LESSON II.

## VENATION.

*Various kinds of leaves, including grass, iris; foxglove, primrose or wood sage; beech, apple, willow, dog's mercury, oak, birch; sycamore or ivy or currant.*

## VEINS OF LEAVES.

1. Distribute specimens. Choose a foxglove or primrose leaf. Draw attention to the lines or veins running in all directions about the blade. They form, as it were, the skeleton of the leaf. The pupils should tell:—

- (a) The stalk is prolonged through the blade to the tip.
- (b) From this, branch out veins which form a *net work*.

2. Now select a grass leaf. Look for the veins. They are not so obvious, at any rate, not such veins as are seen in the dead nettle. Observe the lines running side by side the entire length of the blade. These are the veins, but how different the arrangement! Explain the term parallel, and explain that it is applied to this kind of *veining*.

(a) The foxglove leaf is said to be *net* veined.

(b) The grass leaf is said to be *parallel* veined.

3. Let the pupils classify their specimens as *net* and *parallel* veined leaves

In some leaves the veins are better seen on the under surface, or when they are held up to the light.

## TWO KINDS OF NET VEINING.

1. In the primrose leaf the stalk is prolonged through the blade. Such is called a *midrib*.

2 Take an apple, beech, or dog's mercury leaf. Draw attention to the branching of the veins from the midrib. Make an

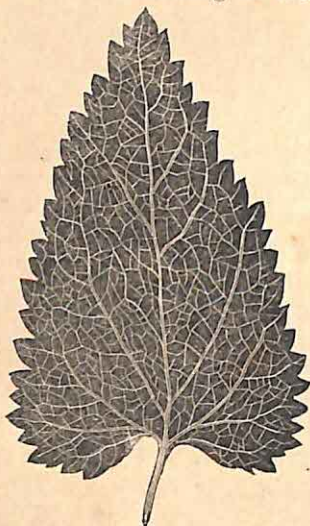


Fig. 4 (a.) Net-veined leaf of Wood Sage (natural size).

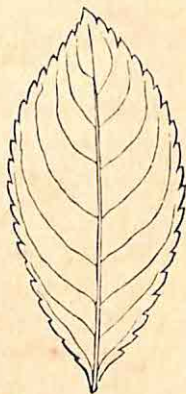


Fig. 4 (b.) Feather-veined leaf of Dog's Mercury ( $\frac{1}{4}$  natural size).

outline drawing on the black board. What may this be likened to? A feather. Such a leaf is said to be feather veined.

3. Take now a sycamore leaf; notice:—

(a) The stalk seems to branch into *five* midribs.

(b) These five spread out like the five fingers from the palm of the hand.

(c) From these ribs branch out the net work of veins.

4. This last kind is called *palmate*, from its resemblance to the *palm* of the hand. Hence net-veined leaves may be:—

(a) Simply net veined.

(b) Feather veined.

(c) Palmate veined.

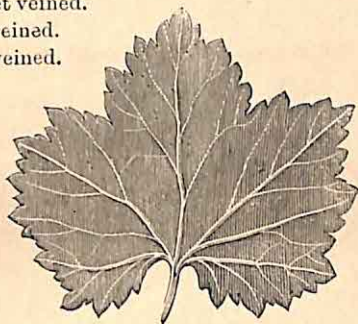


Fig. 4 (c.) Palmate-veined leaf of Red Currant ( $\frac{1}{2}$  natural size).

## THE TERM "VENATION."

We have been speaking of net-veined and parallel-veined leaves, that is, we have spoken of the kind of veins or method of veining found in a leaf. This is called Venation. We shall in future speak of the venation of the leaf. A question to be answered with respect to every leaf will be, "What is its venation?"

## EXERCISE.

Every lesson should be followed by *at least one* exercise like the one now suggested.

Prepare on the black board a little schedule form, and illustrate its use with, say, an ivy leaf. Then let the pupils copy the schedule form and fill it up for one of their own leaves.\*

\* This will be found a most valuable exercise. As the schedule increases the number of exercises should increase.



## LEAF SCHEDULE.

|          |                          |
|----------|--------------------------|
| Parts    | Blade stalk, no stipules |
| Venation | Palmate veined.          |

## LESSON III.

## M A R G I N S.

*Leaves of wallflower, grass, red campion; lime, elder, dog's mercury, balsam, hedge stachys; guelder rose or coltsfoot; pansy, betony, red dead nettle; holly; ivy, sycamore, currant, mustard, oak.*

## THE EDGES OF LEAVES.

1. Specimens distributed. Notice their edges. Compare, for example, those of the campion or wallflower, with the lime or elder.

- (a) The edge of a campion leaf is quite unbroken.
- (b) That of an elder leaf is notched or cut all round.

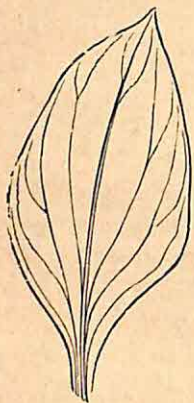


Fig. 5. Leaf of *Lychnis* (red campion) showing entire margin ( $\frac{1}{2}$  natural size).



Fig. 6. Leaf of *Hedge Stachys* with serrate margin ( $\frac{1}{2}$  natural size).

2. Let each separate his own specimens into two sets, of which the campion and elder or hedge stachys are respective types.

3. We shall not speak of edges any longer, but we shall use a word that means the same thing—*margin*. So we may say:—

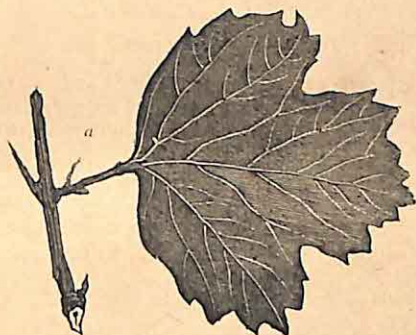
(a) Some leaves have unbroken margins.

(b) Some have notched or cut margins.

Unbroken margins are said to be *entire*.

### KINDS OF NOTCHED MARGINS.

1. Take a balsam or elder leaf. The margin is notched in such a way as to form little points. Observe the direction of these points—*upwards*. Make a drawing. They are like the teeth of a saw. Hence the margin is said to be *saw-like* or *serrate*.



a Stipules.

Fig. 7. Stem bearing leaf of Guelder Rose, showing lobed and *dentate* or toothed margin. The opposite leaf has been removed (Natural size).

2. Now take the leaf of the guelder rose or *coltsfoot*. Observe the direction of the points—*outwards*. Make a drawing. They are thought to resemble teeth, and so the margin is said to be *toothed*. But another word which means toothed is generally used. The man who draws teeth is called a dentist, and a toothed margin is called a *dentate* one. Figs. 7 and 12 (b.)

3. Take a pansy or betony leaf. Observe the margin, and compare with the last example:—

(a) The margin is toothed.

(b) The teeth point outwards, but

(c) They are rounded.

Such margins as these are said to be *crenate*.

4. Observe the leaf of the holly. It is toothed, but the teeth are sharp or *spiny*, hence the margin is said to be *spiny*.

5. Summarize. Notched margins are :—

- (a) *Saw-like* or *serrate* when the teeth point upwards.
- (b) *Toothed* or *dentate* when the teeth are sharp and point outwards.
- (c) *Crenate* when the teeth are rounded.
- (d) *Spiny*, as in the holly.

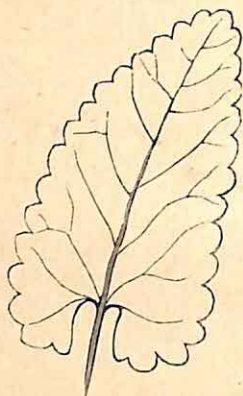


Fig. 8. Leaf of Wood Betony, with *crenate* margin ( $\frac{1}{2}$  natural size.) Only a portion of the long leaf stalk is shown.



Fig. 9. Leaf of Holly, with *spiny (dentate)* margin.

## DEEPER NOTCHES.

1. Observe a sycamore or ivy leaf. Besides the notches just described, there are deep cuts or clefts, and between these large pieces of leaf. These are called *lobes*. Compare with the lobe of the ear.

2. Notice the lobes of some other leaves :—

- (a) The rounded lobes of the oak leaf.
- (b) The irregular lobes of the mustard leaf.
- (c) The serrate lobes of the currant leaf. Fig. 4 (c.)
- (d) The very deeply-cut leaves of monkshood or larkspur.



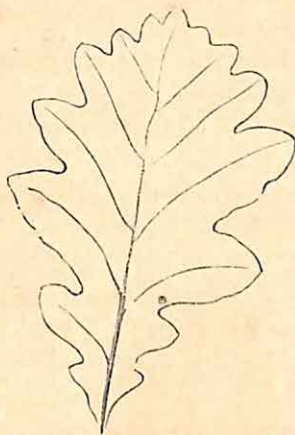


Fig. 10. Leaf of Oak, showing lobed margin. Such a wavy lobed margin is called sinuate ( $\frac{3}{4}$  natural size).

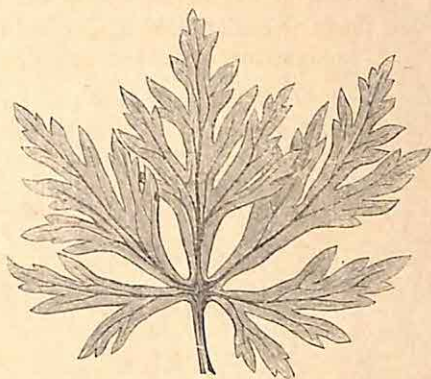


Fig. 11. Five-lobed (lacinate) leaf of Monks-hood ( $\frac{1}{2}$  natural size).

### EXERCISES.

1. Let the pupils classify their leaves according to their margins :—

Entire

Dentate

Spiny

Serrate

Crenate

Lobed

2. Give to each a special leaf to be scheduled under the following heads :—

Parts?

Venation?

Margin?

3. Practise drawing serrate and crenate margins.

N.B. *It is by no means essential that pupils should learn the names of the leaves given to them as specimens. The great point is that they should learn to observe carefully and to describe accurately. If the names are used and written near the drawings, they will be learnt incidentally.*

## LESSON IV.

## APEX &amp; BASE.

*Birch, beech, dead-nettle ; cabbage, alder, dock ; lime, elder, dandelion ; rose, apple ; sycamore, mallow, currant. Leaves of the above.*

## APEX.

1. We are now going to notice that part of the leaf next to the stalk, and the part opposite to it. These we might call the bottom and the top. But we shall call the bottom the *base*, and the top the *apex*, just as in a cone or pyramid, there is a base and an apex.

2. Observe the apex of birch leaf (Fig. 14*a*), compare it with that of a coltsfoot, the first is sharper or more pointed. Compare a dead nettle leaf with a cabbage leaf. Make drawings of the apices. The sharp pointed apex is said to be *acute*, the other *obtuse*. Compare with angles so called.

3. Observe and compare a lime leaf (Fig. 12*c*). Notice how very sharp the point suddenly becomes. Such an apex is said to be *acuminate*.

4. Compare these three forms by making drawings. Let each pupil select leaves from the specimens resembling these.



Fig. 12 (a.) Leaf of Mercury, having apex & base acute.

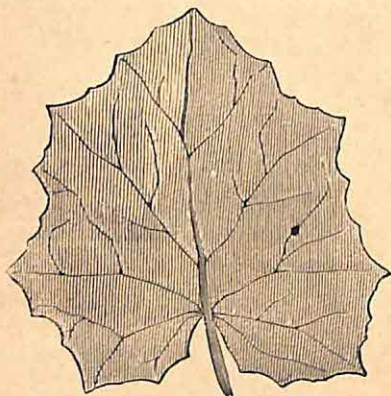


Fig. 12 (b.) Leaf of Coltsfoot, showing dentate margin and obtuse apex ( $\frac{1}{2}$  natural size).

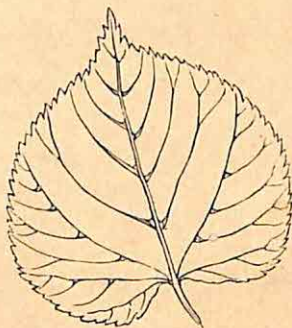


Fig. 12 (c.) Leaf of Lime, with apex acuminate, and base heart-shaped (cordate). Margin is finely serrate.

## THE BASE.

1. Similarly compare the bases of a leaf of oak and one of a rose; a dandelion leaf with an apple leaf. Observe.—

- (a) The oak and dandelion leaves have *acute* bases
- (b) The rose and apple leaves have *obtuse* bases.

2. Take now a sycamore, coltsfoot, mallow, or currant leaf. On each side of the stalk there is a lobe. Hence these bases are said to be *lobed*.

## SUMMARY.

1. The apex of a leaf may be :—

- (a) Acute,
- (b) Obtuse, or
- (c) Acuminate

2. The base of a leaf may be :—

- (a) Acute.
- (b) Obtuse.
- (c) Lobed.

## EXERCISE.

Make a schedule of, say, a sycamore leaf as below, and afterwards allow each child to schedule another leaf.

|          |                           |
|----------|---------------------------|
| Parts    | Blade, stalk, no stipules |
| Venation | Palmate veined            |
| Margin   | Lobed and serrate.        |
| Apex     | Acute.                    |
| Base     | Lobed.                    |

1. Draw dentate, serrate and crenate margins.
2. Write a description of an oak leaf as if it were in its own words.
3. Draw any of the leaves that have been taken in this lesson and write the names of their parts.

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## LESSON V.

## SIMPLE &amp; COMPOUND LEAVES.

*Leaves of oak, ivy, &c.; rose, mountain ash (or rowan), ash, bramble, vetch, meadow-sweet, clover, raspberry, horse-chestnut, hogweed, hemlock, elder, cinquefoil, &c.*

## DIVISION OF THE BLADE.

1. Specimens distributed, let each compare a rose leaf with an oak leaf:—

(a) The oak leaf is made of one single piece.

(b) The rose leaf is made up of *seven* pieces.

2. Carefully observe that these pieces are quite separate, like seven leaves; each is called a leaflet. Now how are we to know that these are not seven leaves?

(a) All the seven are attached to one stalk.

(b) At the base of the stalk is a pair of stipules, which only grow at the foot of a leaf stalk.

(c) When the leaves fall from the trees in autumn, all the seven leaflets will fall away together with the stalk to which they are attached.

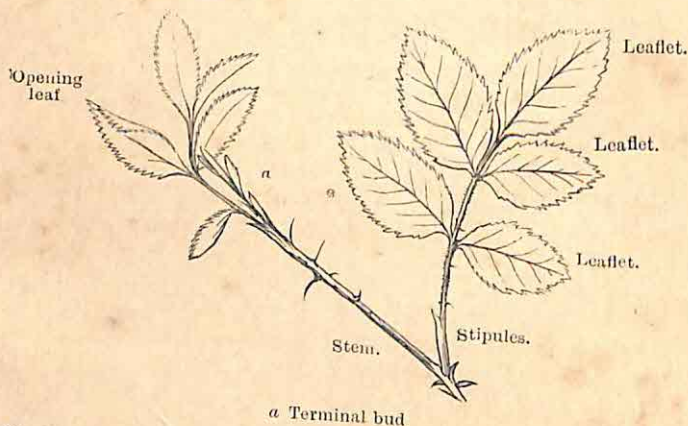


Fig. 13 (a.) Compound leaves of Wild Rose attached to the stem, showing stipules and prickles. In the upper leaf the terminal leaflet is concealed.

We are therefore right in saying that these seven pieces constitute one leaf.

3. Compare similarly two others, an ivy and an elder.

4. Classify the specimens. Those whose blades are in one piece are called *simple* leaves, but those whose blades are composed of *separate* pieces or leaflets are called *compound* leaves. In saying whether a leaf is simple or compound we shall be speaking of its *composition*.

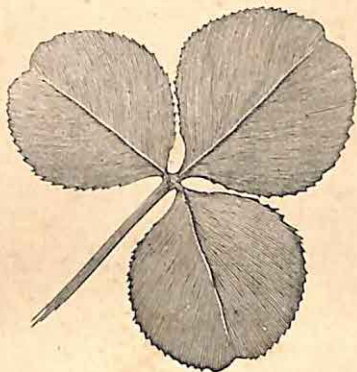


Fig. 13 (b.) Compound leaf of Clover. The apex of each leaflet is notched, and is called *emarginate*.

## COMPOUND LEAVES.

1. Contrast the following leaves:—

|              |   |      |   |                    |
|--------------|---|------|---|--------------------|
| Ash          | } | with | { | Horse-chestnut     |
| Meadow-sweet |   |      |   | Cinquefoil         |
| Elder        |   |      |   | Clover or trefoil  |
| Rose         |   |      |   | ° Wood sorrel      |
| Hogweed      |   |      |   | Bramble, raspberry |
| Hemlock      |   |      |   |                    |

Lead pupils to observe:—

- In the former set the leaflets grow from the prolonged leaf stalk.
- In the latter, all radiate from one point.
- In the former there is a likeness to the *feather* veining.
- In the latter there is a likeness to the *palmate* veining.

## 2. Notice carefully :—

- (a) A compound leaf terminates in a leaflet (or tendril).
- (b) A stem bearing leaves terminates in a bud (or flower).
- (c) In a compound leaf all the leaflets are of the same age.
- (d) On a stem bearing leaves, the oldest leaves are at the bottom and the youngest at the top.

## EXERCISE.

*Schedule specimens as before, with the addition of "Composition." Three or four lessons might well be devoted to exercises of this kind before proceeding further.*

## LESSON VI.

## SHAPES OF LEAVES (1).

*Leaves of lime, birch, broad-leaved plantain, and plum.*

## THREE LEADING SHAPES.

1. Specimens distributed, notice carefully the shapes of the leaves. Take the lime leaf (Fig. 1), and laying it on board, slate, or paper, trace its outline. What is the shape thus drawn? Almost a circle—*round*.

2. Do the same with the broad-leaved plantain or birch leaf. Notice it is narrow at one end and broad at the other. What object does this outline suggest? An egg. This leaf is said to be egg-shaped. But we generally use another word which means egg-shaped. We say the shape of such a leaf is *ovate*.

3. Treat in a similar way the leaf of a plum. The same shape is produced but inverted. This shape then is *ovate*, but *upside down*. To express this we say it is *obovate*.

## CHARACTERISTICS.

1. Summarize. We have noticed three leaves and found the following shapes :—

- (a) Round.
- (b) Ovate or egg-shaped.
- (c) Obovate.



2. Refer to the drawings of the shapes already made. Let each pupil draw a line from apex to base, representing the midrib of the leaf.

3. Now let each pupil draw a line at right angles to this line to represent the breadth, and at the broadest part of the drawing. Lead to the following observations :—

- (a) The round leaf has its broadest part *across* the middle.
- (b) The ovate leaf has its broadest part *below* the middle.
- (c) The obovate leaf has its broadest part *above* the middle.



Fig. 14 (a.) *Ovate* leaf of Birch (natural size). Broadest below middle.



Stipules.

Fig. 14 (b.) *Obovate* leaf of Plum (natural size) broadest above middle.

4. In describing the shape of a leaf then, we must first notice *where the broadest part is*. If the leaf is lobed we must trace the outline from point to point as if the clefts were filled up. Thus we get the general outline or shape.

### EXERCISE.

*The following will serve as good specimens to be distributed. (Each pupil should trace the outline of his specimen and name the shape):—* mallow, oak, currant, chickweed, hazel.

## LESSON VII.

## SHAPES OF LEAVES (2).

*Leaves of the following:—(1) lime, hazel, coltsfoot, lady's mantle, (2) rose; (3) dock or chestnut; (4) candytuft or toad-flax; (5) pine.*

## SHAPES OF THE FIRST CLASS.

1. Each pupil should be supplied with at least one out of each of the above five sets of leaves. Sketch their outlines.

2. Draw a line from apex to base in each, and another across the widest part.

3. Notice:—

(a) The first is round.

(b) The others, like it, are broadest across the middle, or at any rate, are nowhere broader than across the middle.

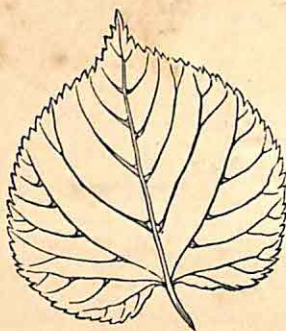


Fig. 15. Round (or orbicular) leaf of Lime.



Fig. 16. Elliptical leaflet of Elder.



Fig. 17. Oblong leaf of Chestnut ( $\frac{1}{2}$  natural size). Margin, dentate; feather-veined; apex, acute; base, obtuse.

4. Compare these five shapes. Going from left to right, each is broader in proportion to its length than the one before it. Figs. 15 to 19.

## NAMES OF THESE SHAPES.

1. Compare (Fig. 16) with (Fig. 15). It is like a flattened circle. Such a shape is called an *ellipse*. Hence leaves of this shape are said to be *elliptical*.

2. Round Fig. 17 sketch an oblong. The oblong is almost filled. Such a leaf is said to be *oblong* in shape. Compare with the *ellipse*.

3. The fourth shape is very narrow compared with its length. So narrow is it that it has been likened to a *line*, and called *linear*.

4. The last is still narrower. It is pointed, and thought to resemble a *needle*.

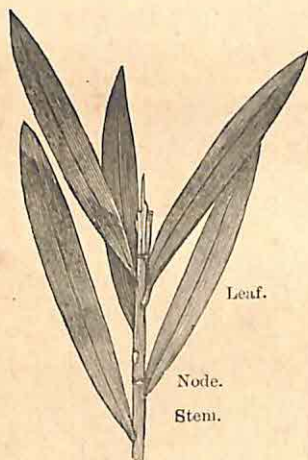


Fig. 18. *Linear* leaves of Candytuft on stem (natural size).



Fig. 19. Needle-shaped leaves of Scotch Pine.

5. Let us now put together what we have learnt about the shapes of these leaves.

- (a) The first is as broad as long—*round*.
- (b) The second not quite as broad as long—*elliptical*.
- (c) The third is similar, but tapers less towards the apex and base—*oblong*.
- (d) The fourth is very narrow—*linear*.
- (e) The last very narrow and pointed—*needle-shaped*.



6. We have thus five shapes, all of which are nowhere broader than across the middle.

### EXERCISE.

(To be taken in a following lesson.)

Make drawings, and name the shapes of any or all of the following leaves:—lime, coltsfoot, beech, lily of the valley, alder, currant, leaflets of ash and elder, red campion, leaflets of mountain ash, willow, yew, and pine.

## LESSON VIII.

### SHAPES OF LEAVES (3).

Leaves of (1) yellow pimpernel, broad leaved plantain, birch; (2) hedge stachys, violet; (3) willow herb, dog's mercury, dead nettle; (4) ground ivy; (5) stitchwort.

### SHAPES OF THE SECOND CLASS.

1. Each pupil should be supplied with at least one leaf of each of the above five groups. Sketch their shapes as in last lesson.

2. Lead to observations:—

(a) All these leaves are broadest below the middle.

(b) All taper off towards the apex.



a Terminal bud (growing point).  
b Axillary bud (growing point).

Fig. 20. Ovate leaves of Yellow Pimpernel on stem; flower in the axil of one of the lower leaves.



Fig. 21. Cordate leaves of Wood Violet (natural size).

## NAMES OF THESE SHAPES.

1. The name of shape (1) we have already learnt—egg-shaped or *ovate*.

2. Compare (2) with (1)—the difference lies in the lobes of the base and the curvature of the margins. Invert the specimen or make an inverted sketch. What does the shape now remind you of? A heart. Such a leaf is *heart-shaped*. It is usual to call it by a Latin name, which means the same thing—*cordate* (cf. *cordial*).

3. Compare shape (3) with (1) and (2).

(a) It is more pointed towards the apex.

(b) It is narrower, and pointed a little towards the base.

Compare it with a lance head.



Fig. 22. *Lanceolate* leaves of Willow Herb on stem (natural size).



Fig. 23. Lance Head.

As it resembles this in shape, it is said to be *lance-shaped*, or as we generally say, *lanceolate*.

4. Observe shape (4):—

(a) It is not long or pointed.

(b) It has a base like the *heart-shaped* leaf.

Make a drawing of a kidney; and the resemblance is seen at once. Such a leaf is said to be *kidney-shaped* or *reniform*.

5. The last one is thought to resemble an *awl*, and is called *awl-shaped*.

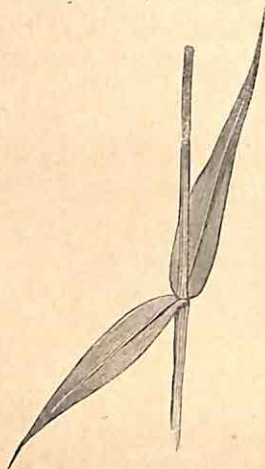


Fig. 24. Two *awl-shaped* (*subulate*) leaves of *Stitchwort* on stem (nat. size).

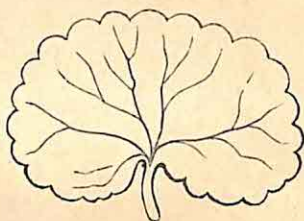


Fig. 25. *Kidney-shaped* (*reniform*) leaf of *Ground Ivy*, with crenate margin (slightly enlarged).

## SUMMARY.

Of those leaves which are broadest *below* the middle we have:—

- |                   |    |              |
|-------------------|----|--------------|
| (a) Egg-shaped    | or | ovate.       |
| (b) Heart-shaped  | or | cordate.     |
| (c) Lance-shaped  | or | lanceolate.  |
| (d) Kidney-shaped | or | (reniform).* |
| (e) Awl-shaped    | or | (subulate).* |

## EXERCISE.

(As after the previous lesson.)

Suitable leaves for the purpose are any of those mentioned at the head<sup>2</sup> of this lesson.

\* These names need not be given.



## LESSON IX.

## SHAPES OF LEAVES (4).

Leaves of (1) plum, oak, or elm; (2) wood-sorrel (leaflets); (3) dandelion, honey-suckle; (4) horse-chestnut.

## SHAPES OF THE THIRD CLASS.

1. Each pupil being supplied with specimens of all the above four groups, make drawings as before. Observe:—

- (a) In each case the point is at the base.
- (b) The leaves are all broadest *above* the middle.

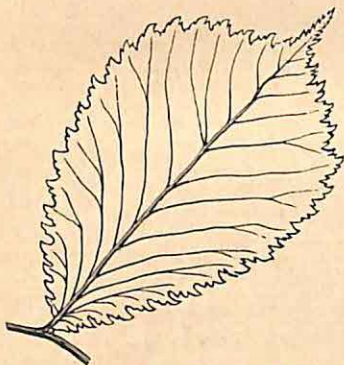


Fig. 26. Obovate leaf of an Elm ( $\frac{2}{3}$  nat. size).

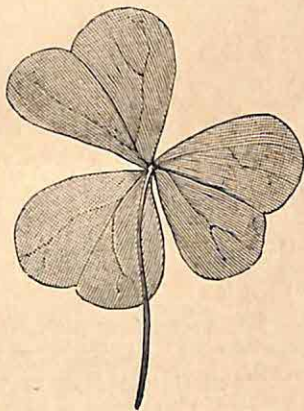


Fig. 27. Compound leaf of Wood Sorrel with *obcordate* or inverted heart-shaped leaflets (natural size). The apex of each is *emarginate* (natural size).

## NAMES OF THESE SHAPES.

1. The first three shapes should be compared with the first three of the last lesson.

- (a) The first is egg-shaped (ovate), but the broad part is at the apex.
- (b) Such we learnt in lesson VI. was called *obovate*.
- (c) The second is *heart-shaped*, but the point is downwards.
- (d) The third is *lanceolate*, and the point is also downwards.

2. These shapes are accordingly named:—

- (a) Obovate.
- (b) Obcordate.
- (c) Oblanceolate.

3. The fourth leaf, a horse-chestnut, has leaflets which are more angular in shape. Each resembles a *wedge*, and is said to be *wedge-shaped*.

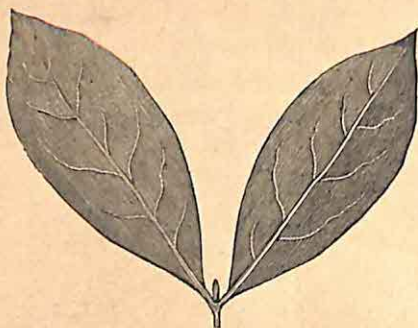


Fig. 28. Two *oblanceolate* leaves of Honey-suckle attached to stem.



Fig. 29. Compound seven-fingered *digitate* leaf of Horse chestnut, with *oblanceolate* or *wedge-shaped* leaflets ( $\frac{1}{2}$  nat. size).

*Note.* It may be found helpful in determining shapes, to fold leaves, bringing the point of the apex to the foot stalk.

### EXERCISE.

A good selection of leaves should be taken of all the shapes so far dealt with. Specimens of each shape should be pressed between sheets of paper, and when dry, mounted on cards or sheets of white paper, with the aid of very thin glue or gum tragacanth.

Learn to draw from memory the following leaves; write the name of each beneath and describe its shape:—

Oak.

Elm.

Willow.

Coltsfoot.

Beech.

Poplar.

Chestnut.

Birch.

## LESSON X.

## SHAPES OF LEAVES (5).

Leaves of (1) sorrel; (2) bindweed, arrow head; (3) marigold, London pride or ox-eye daisy.

## IRREGULAR SHAPES.

1. These shapes are irregular in the sense that they do not come within the category of those already taken, though they might all be considered as modifications of *lanceolate*.

2. Examine as before, making drawings and compare :—

(a) With a spear or halberd—hence it is *halberd-shaped* (Fig. 30).

(b) With an arrow head—hence it is *arrow-shaped* (Fig. 31).

(c) With a spoon—hence it is *spoon-shaped* (Fig. 32).

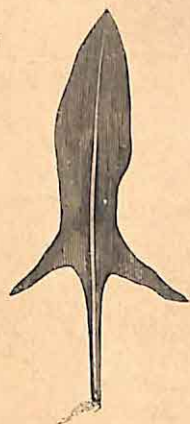


Fig. 30. Halberd or spear-shaped (*hastate*) leaf of Sheep's Sorrel (nat. size).



Fig. 31. Arrow-shaped (*sagittate*) leaf of Bindweed or Field Convolvulus with obtuse apex (nat. size).



Fig. 31 (a.) Cordate arrow-shaped leaf of Black Bindweed.

## REMARKS ON SHAPES.

1. In the case of compound leaves it is usual only to describe the shape of the leaflets.



2. Leaves are often found whose shapes do not exactly correspond to those taken above. In such a case it must be noticed what two shapes are most nearly approached, and a combination of the two terms must be applied, thus:—

- (a) A grass leaf is—linear-lanceolate
- (b) An arum leaf is—oblong-arrow-shaped.
- (c) A scrophularia leaf is—oblong-ovate.

3. In judging the shape, decide first whether:—

- (a) Broadest across the middle.
- (b) Broadest below the middle.
- (c) Broadest above the middle.

### SUMMARY.

- (a) Broadest across middle—round.  
elliptical.  
oblong.  
linear.  
needle-shaped.
- (b) Broadest *below*—ovate  
cordate  
lanceolate  
kidney-shaped  
awl-shaped
- (c) Modifications of *lanceolate*
- above*—obovate.  
obcordate.  
oblanceolate.  
wedge-shaped.  
halberd-shaped.  
arrow-shaped.  
spoon-shaped.



Fig. 32. Spoon-shaped (spathulate) leaf of Common Marigold.

### EXERCISE

(Specimen schedule of a rose leaf.)

|             |                          |
|-------------|--------------------------|
| Parts       | Blade, stalk, stipules.  |
| Venation    | Veather-veined.          |
| Margin      | Finely serrate.          |
| Apex        | Obtuse.                  |
| Base        | Obtuse.                  |
| Composition | Compound—seven leaflets. |
| Shape       | Elliptical.              |

Four or five lessons in scheduling before passing on to Lesson XI.

## LESSON XI.

## LEAF AND STEM.

*Various leaves, including such as (1) oak, lime, beech; (2) dandelion; (3) shepherd's purse, pansy.*

## STEM LEAVES AND "ROOT" LEAVES.

1. Take for example, some dandelion plants and leaf-bearing stems of any tree. Notice what the leaves grow from:—

- (a) Dandelion leaves grow from the top of the root.
- (b) Oak leaves grow from a branch or stem.

2. Take other examples, and it will be observed that leaves always grow from either stem or the top of the root. Hence from their *position* on the plant leaves may be classified as:—

- (a) Stem leaves.
- (b) Root leaves.

3. It will be seen further on that leaves do not grow actually from the root, but in the case of such plants as the dandelion and primrose, the stem is so exceedingly short that the leaves grow close together in a rosette at the top of the root.

4. Except for the reason just stated, the above terms would do very well; they may be used, but generally,

- (a) Stem leaves are said to be *cauline*.
- (b) Root leaves are said to be *radical*.

## HOW LEAVES ARE ATTACHED OR INSERTED.

1. We have just seen *where* leaves are attached and named them accordingly; now let us observe *how* they are attached to the stem.

2. Compare such a leaf as that of a beech with the dandelion or shepherd's purse. In these cases the parts are:—

- (a) In the beech leaf, blade and stalk.
- (b) In the dandelion, blade only.

3. In the former case the leaf is attached or *inserted* as we say

by its *stalk*, in the latter the leaves are *inserted* without stalks. So we may say that these leaves are respectively,

- (a) Stalked.
- (b) Stalkless.

### TERMS GENERALLY USED.

1. The leaf with a stalk stands on the stem, as it were, by means of a *little foot*, the name for which is *petiole*. So we say a *stalked* leaf has a *petiole*, or that its insertion is *petiolate*.

2. The leaf without a stalk has no little foot on which to stand, so it is said to *sit* on the stem, and its insertion is said to be *sessile*, a word which means *sitting*.

3. Insertion then may be either :—

- (a) Petiolate, or
- (b) Sessile.

4. Observe the leaves of a pansy. The parts are :—

- (a) Blade.
- (b) Petiole.
- (c) Stipules.

Hence its insertion is petiolate, and something more. It is petiolate with stipules (or stipulate). If there are no stipules, the leaf is *exstipulate*. Therefore we have three kinds of insertion :—

- (a) Sessile.
- (b) Petiolate and exstipulate.
- (c) Petiolate and stipulate.



Fig. 33. Leaf of Elm, *sessile* on stem, i.e., attached without a foot-stalk or petiole ( $\frac{1}{3}$  nat. size).



## LESSON XII.

## ARRANGEMENT OF LEAVES.

Branches bearing leaves of (1) mint or any labiate; (2) wallflower, rose, hawthorn, bramble, or hazel; (3) woodruffe, crosswort, bedstraw, or goosegrass

## OPPOSITE OR ALTERNATE.

1. Let each pupil have a stem of mint or wallflower, or any other out of groups (1) and (2) above. Each should make a diagrammatic drawing representing the stem by a straight line, and the leaves by curved ones.



Fig. 34. Opposite leaves of Willow Herb.



Fig. 35. Alternate leaves of Candytuft.

2. Thus we are led to observe:—

- (a) The leaves of the mint are arranged in pairs.
- (b) The leaves of the wallflower are arranged singly.

3. We have then two arrangements of leaves on stems. Take other examples from (1) and (2) above.

4. When the leaves are in pairs, the arrangement is said to be *opposite*, because leaves stand opposite one another on the stem; in the other case when they are arranged singly or on each side of the stem *alternately*, the arrangement is said to be an *alternate* one.



Fig. 86. Stem, with leaves of Crosswort; leaves arranged in *whorls* of four ( $\frac{1}{4}$  nat. size).

## A WHORL.

1. Observe the arrangement of the leaves in one of the specimens suggested in group (3) above. It will be seen that they grow in rings of 4 in crosswort, of 6 in bedstraw, and of 8 in woodruffe. Such rings as these are called *whorls*. The arrangement is said to be a *whorled* one.

2. To summarize, we have three arrangements:—

- (a) Alternate (in ones).
- (b) Opposite (in twos).
- (c) Whorled (in fours, sixes, or eights).

*Note.* Very often opposite leaves are so arranged that each pair is at right angles to the next pair, that is to say, if any one pair points left and right, the next pair points to front and back.

## EXERCISES.

We shall now make a schedule of the leaves of shepherd's purse as an example. Several others should be made by each pupil.

## LEAF SCHEDULE.

|             |                                                   |
|-------------|---------------------------------------------------|
| Position    | Radical and cauline.                              |
| Insertion   | Sessile.                                          |
| Arrangement | Alternate.                                        |
| Venation    | Net-veined.                                       |
| Margin      | Radical—deeply lobed ; cauline—dentate.           |
| Composition | Simple.                                           |
| Apex        | Acute.                                            |
| Base        | Radical—acute ; cauline—arrow-shaped.             |
| Shape       | Radical—oblanceolate ; cauline—linear lanceolate. |

1. Name all the plants you know whose leaves grow in a rosette. (Plantain, dandelion, thistle, &c.)
2. Having examined one of these plants, sketch a circle, fix a point for centre, and then draw straight lines to represent the directions of the leaves.
3. What arrangement of leaves does it show ? (Alternate).
4. Why does an ivy leaf usually grow five-pointed ?
5. Compare a laurel leaf with an ivy leaf. Why cannot the laurel leaf grow five-pointed also ?
6. Draw from memory the following leaves :—Oak, beech, elm, poplar, laurel, Spanish chestnut, and willow.



## LESSON XIII.

## COMPOUND LEAVES.

Leaves of (1) rose, elder, ash, mountain ash, vetch, acacia, fool's-parsley, angelica; (2) clover, strawberry, bramble, horse-chestnut, lupin.

## TWO KINDS.

1. Recall the distinctions between a simple and a compound leaf. Compare a rose-leaf with a horse-chestnut leaf:—

- (a) In the rose-leaf the plan of division is that of feather veining.
- (b) In the chestnut leaf it is that of palmate veining.

2. The former may thus be likened to a feather, the latter to the fingers of the hand. As the Latin word for a feather is *pinna* (from which we get *pen*, i.e., a *quill*) such a leaf as an ash or rose is called *pinnate*. Similarly, as the Latin word for finger is *digitus* (cf. *digit*), we call such leaves as the horse-chestnut, *digitate*.

3. Make a classification of specimens into :—

- (a) Compound pinnate leaves.
- (b) Compound digitate leaves.

## PINNATE LEAVES.

1. A rose, elder, or mountain ash leaf is simply divided once, but compare with these an acacia leaf or one of fool's parsley and one of angelica.

- (a) In the acacia leaf, each leaflet seems to be again divided into secondary leaflets
- (b) In the angelica leaf there are secondary leaflets, and these are divided into leaflets

2. The former is said to be *twice* (or *bi-*) *pinnate*, and the latter *thrice* (or *tri-*) *pinnate*. The first class of compound leaves may then be :—

- (a) Pinnate, or
- (b) Bi-pinnate, or
- c) Tri-pinnate.

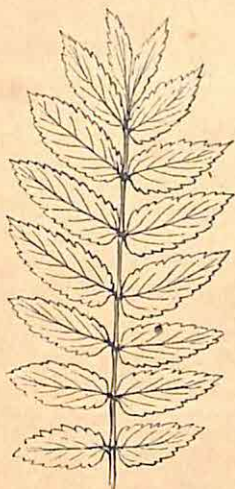


Fig. 37. Compound *pinnate* leaf of Mountain Ash. The terminal leaflet is double in the specimen here represented ( $\frac{1}{2}$  nat. size).

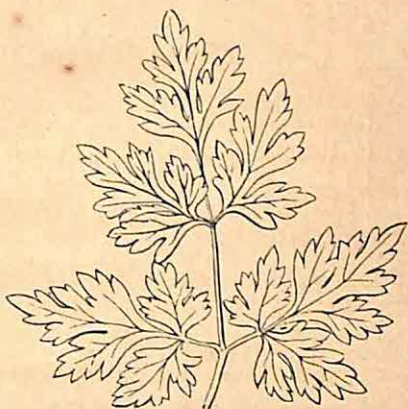


Fig. 38. Compound twice-divided leaf of Fool's Parsley (twice pinnate or more accurately in this example, twice ternate).

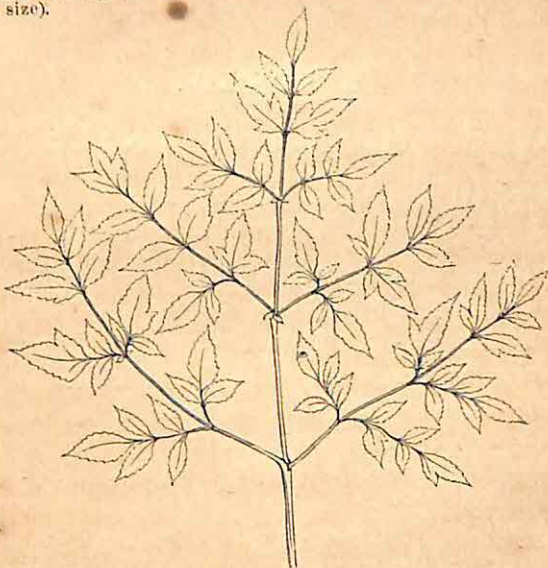


Fig. 39. Compound three times pinnate (tripinnate) leaf of Angelica (about  $\frac{1}{2}$  nat. size).

## DIGITATE LEAVES.

1. By comparing the specimens of digitate leaves mentioned at the head of this lesson, it will be seen that they differ in the number of fingers.

- (a) Clover is three-fingered.
- (b) Strawberry is three-fingered.
- (c) Bramble is three-fingered, and in some species five-fingered.
- (d) Horse-chestnut is five or seven-fingered.
- (e) Lupin is thirteen fingered.

## EXERCISE.

*In making schedules now, be careful to state in the case of a compound leaf whether it is pinnate or digitate; if the former, whether once, twice, or thrice; if the latter, how many fingered.*

Suitable leaves to draw are:—*Ash, strawberry, bramble, clover, laburnum.* They may be drawn with pencil in outline or in mass with brush.

## LESSON XIV.

## LEAVES AND THEIR SKELETONS.

*Leaves of (1) dandelion, field scabious, shepherd's purse; (2) ivy, sycamore, monk's-hood or meadow crane's-bill.*

## SIMPLE OR COMPOUND?

1. We shall now be able to find a complete answer to a question that was asked at the end of Lesson XII.

2. Having as many leaves suggested above as possible, we examine them carefully and observe:

(a) All have very uneven margins.

(b) The margins may be described as lobed, sharp-pointed, or deeply cut.

3. But are they simple or compound leaves? In which of the leaves do the cuts go down to the centre or mid-



rib? Is any one of them divided into separate pieces or leaflets?

(a) None of the leaves are entirely divided.

(b) They are not compound leaves.

4. Take up the dandelion leaf. Trace a line round it, touching its points. Imagine the figure so formed quite filled up as a leaf blade. What is the result?

(a) It becomes a simple undivided leaf.

(b) In shape it would be called oblanceolate.

### THE LEAF SKELETON—DANDELION.

1. Each pupil makes a sketch as suggested.

2. We now wish to put in the points. What will help us to find them? Notice:

(a) A strong branch vein (or rib) runs from the mid-rib to each point.

(b) All the other branches are weak.

3. We then sketch in these strong branches and complete the drawing of the leaf.



Fig. 40. *Runcinate* leaf of Dandelion—lobes pointing downwards ( $\frac{1}{2}$  natural size).

4. We thus see that the points or pieces are about the strong branches or side ribs, and the form of the skeleton determines the form of the leaf. Briefly stated.

(a) The skeleton consists of one strong mid-rib with side ribs branching from it after the manner of a feather.

(b) The growth of the leaf blade follows the principal ribs.

5. It will be interesting to add that the dandelion takes its name from the appearance of its leaf points—lion's teeth. (*French*, *dent de lion* = lion-tooth).

### ANOTHER FORM.

1. Take an ivy or sycamore leaf and deal with it exactly as with the dandelion leaf above. The following should be arrived at:—

(a) The ivy leaf has five principal or strong ribs.

(b) They radiate or branch from the top of the leaf stalk.

(c) The general shape of the leaf is round.

(d) As the growth follows the principle ribs, the leaf becomes a five pointed one.

2. By observing a number of leaves it will be found that they all conform to one or other of these types—either *pinnate* or *palmate*.

### QUESTIONS FOR THOUGHT.

1. If a dandelion leaf were more deeply cut so that its lobes became separate pieces, what kind of a leaf would it be?
2. Why is a sycamore leaf five-pointed?
3. Why is an oak leaf many lobed (about 12)?
4. Why are the leaflets of a rose arranged differently from those of the horse-chestnut?
5. If the growth of a coltsfoot leaf were uneven and followed the principal veins, what kind of a leaf would it become?

## LESSON XV.

### LEAVES: THEIR COATS & COLOURS.

*Leaves of* (1) *elm*, *comfrey*, (2) *foxglove* or *hazel*, (3) *colts-foot*, (4) *oak* or *hawthorn*, (5) *silverweed* *woundwort*, (6) *holly*, *ivy*, *copper beech*.

## LEAF SURFACES.

1. We take leaves from the different groups as suggested above, and have them passed through the fingers. It will at once be pronounced that:

(a) Some are rough.

(b) Others are smooth.

2. A little more careful feeling will show that there are various degrees of roughness. Holding up a leaf like that of the elm to the light, it will be seen that its surface is covered with rather strong hairs.

3. We next take a foxglove leaf, then a coltsfoot, silverweed and woundwort.

(a) The foxglove leaf is *downy*.

(b) The coltsfoot leaf seems to be covered with cotton.

(c) The silverweed leaf seems to be covered with silk on its lower surface.

4. We now contrast with these an oak or hawthorn leaf. Neither hairs nor cotton are to be seen or felt. Such leaves are usually described as *glabrous*.

## COATS.

1. We thus see that many leaves wear coats of different kinds.

(a) Hairy—elm.

(b) Downy—foxglove and hazel.

(c) Cottony—coltsfoot.

(d) Silky—silverweed and woundwort.

(e) Glabrous (no coat)—oak, holly, ivy.

2. Now what purpose do these coats serve? "To keep them warm." Perhaps. But coats are sometimes worn for another purpose? "To keep out the wet." This is probably the chief use of leaf coats.

3. Seen under the microscope some of the hairs are exceedingly pretty and of various forms.



## COLOURS.

1. We generally think of all leaves as green; but if we wish to make drawings of them and colour them naturally, we soon find out how various are the greens, *e.g.*:—

(a) Holly is very dark green.

(b) The beech is a pale yellowish green in spring.

(c) All leaves darken in colour as the summer advances, and many change still further in autumn.

(d) The silky-coated leaves are almost white.

(e) The copper beech has purplish leaves.

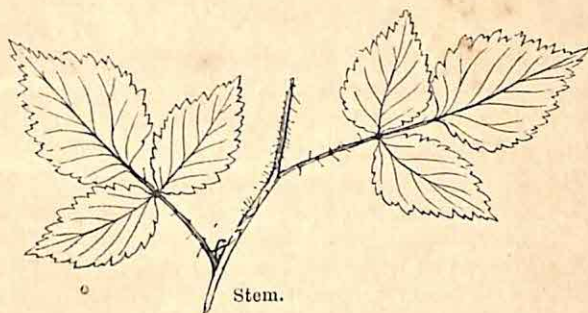
2. To describe a plant accurately then, we must not only say what kind of coat it wears, but also give its colour, and notice whether the colour is the same on the upper surface as underneath.

## EXERCISE.

We will take a raspberry leaf and make a table or schedule of all its characters.

## SPECIMEN LEAF SCHEDULE OF RASPBERRY.

|             |                                                                                |
|-------------|--------------------------------------------------------------------------------|
| Position    | Cauline.                                                                       |
| Insertion   | Petiolate, stipulate.                                                          |
| Arrangement | Alternate.                                                                     |
| Venation    | Feather veined (pinnate).                                                      |
| Margin      | Serrate.                                                                       |
| Composition | Compound—(3 leaflets).                                                         |
| Apex        | Acuminate.                                                                     |
| Base        | Obtuse.                                                                        |
| Shape       | Ovate (leaflets).                                                              |
| Surface     | Slightly hairy above, downy beneath,<br>with prickles on the petiole & midrib. |
| Colour      | Dark-green above, white beneath.                                               |



a Stipules.

Fig. 41. Two compound three-fingered (*digitate* or *ternate*) leaves of Raspberry on stem ( $\frac{2}{3}$  natural size).

## LESSON XVI.

## AUTUMN LEAVES.

*Leaves in Autumn tints: (1) beech, oak, spanish chestnut, bramble, sycamore; (2) ivy, holly, laurel. (It is better that they should all be on twigs.)*

## CHANGE OF COLOUR.

1. One of the sure signs of the coming winter is the beautiful tints that come over our woods, hedgerows and plantations.

"Bright-yellow, red and orange,  
The leaves come down in hosts;  
The trees they are Indian princes,  
But soon they'll turn to ghosts."

2. To-day we will think of them as Indian princes, and talk of them as ghosts when they have lost their present beauty.

3. Nothing will so well promote careful observation as allowing the pupils to make water-colour drawings from their specimens. (The bramble will probably be a difficult

colour to get, but the beech, oak, chestnut and sycamore are easy). We may notice a few points:—

- (a) The oak leaf is light brown, has very straight ribs, and as many lobes as ribs.
- (b) The beech leaf is reddish brown, has also straight ribs, but a slightly wavy margin due to shrinking between the ribs.
- (c) The chestnut leaf is light brown, like the oak, and straight ribbed, with a sharp toothed margin. There are as many teeth as ribs.
- (d) The sycamore is a five-pointed leaf, having the palmate style of veining. It varies much in colour; sometimes a lemon-yellow, later a very dark brown.
- (e) Bramble leaves are compound of either three or five leaflets. The venation is similar to that of the sycamore leaf, but the leaf blade follows the main ribs so closely that separate leaflets are formed.

4. The colours of the bramble leaf are often very beautiful—purple, yellow, scarlet, and sometimes all these colours in one leaf.

### EVERGREENS.

1. In contrast with the leaves above are some that do not change colour, the ash for example. But to all these leaves it will have been noticed what happens when autumn winds and frosts come. Whereas there are other leaves that appear to be unaffected by wind or frost.

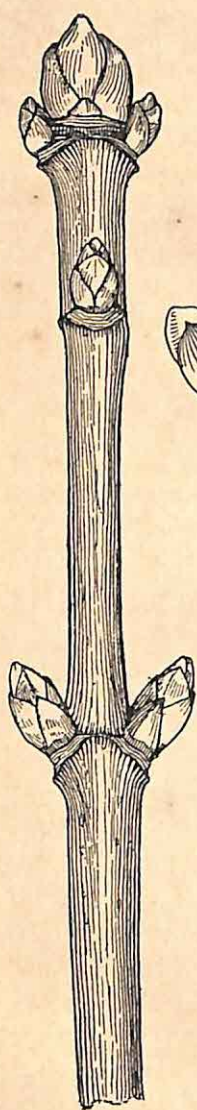
- (a) The leaves of most of our large trees fall off in the autumn, in most cases after they have gone through various changes of colour.

- (b) The leaves of the holly, ivy and laurel do not fall off.

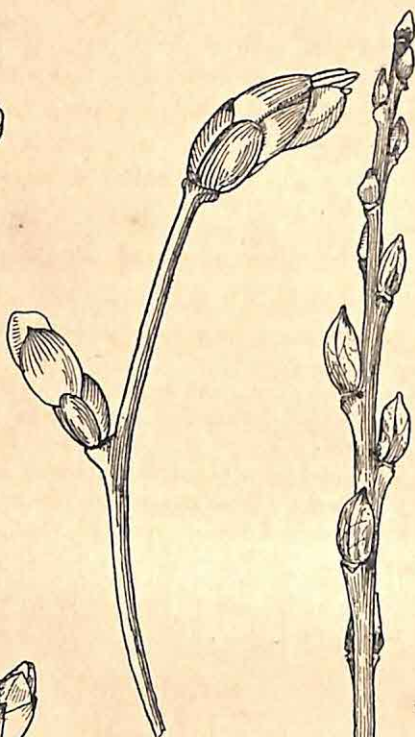
2. Nothing can exceed the beauty of a wood on a hill-side in all the richness of its varied colours. It is also refreshing to see the bright green of holly and ivy during the winter, when all other leaves have gone.

3. But do these leaves ever fall? The question is easily answered by looking under holly bushes. The ground





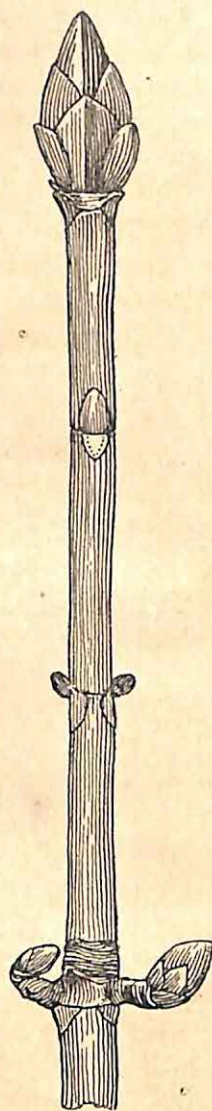
Ash.



Lime.



Willow.



Sycamore.

Fig. 41a. Buds enlarging on the approach of Spring.  
The larger buds of the Willow contain flowers ("palms").

is generally found covered with a deep layer of dead holly leaves. The fact is, holly and ivy leaves fall, but not all at once, or in the autumn. Such plants have always green leaves on them, and hence are called *evergreen*; whereas leaves that fall annually are called *deciduous*.

### QUESTIONS.

The following questions are proposed for the pupil to answer from his own observation :—

1. What difference is there between a deciduous leaf and one of an evergreen plant?\*
2. Why then should beech and oak leaves fall in the autumn?
3. If you saw a holly tree without leaves, what might you think about it?
4. If a branch is lopped off a beech or oak during the summer, and left untouched, what happens to the leaves?
5. Write a list of evergreens that grow in your own neighbourhood.

\* The evergreen leaf is protected by a thick, tough skin, which gives it its tough, leathery appearance.

## LESSON XVII.

### TREES IN WINTER.

*The twigs used last lesson will furnish material for this, especially if the leaves have fallen off. Other twigs may be added that have lost their leaves on the tree. A few horse-chestnut twigs should be at hand.*

#### THE WINTER SLEEP.

1. Frosty mornings and windy days set the leaves flying, and very soon our tall trees stand gaunt and bare. If a snowstorm comes, then they look like real ghosts. Then we can see the tree's form unhidden by leaves. For if we observe carefully we shall find that every kind of tree has its own mode of branching.

2. But let us notice some of the twigs we have at hand. Look where the leaves have fallen away.

(a) There is a small scar where a leaf has been.

(b) The scar is smooth and shiny.

3. The smooth shiny surface is formed of cork, like the bark. So we may see that the falling of the leaf is a natural process that has been provided for. It was not the wind or the frost; they simply hastened the fall for which preparation had for some time been going on. Very large scars are to be seen on horse-chestnut stems. The ends of the detached veins may easily be counted.

### CHARACTERS OF A STEM.

1. The chief features of a stem may easily be observed. It will be noticed that the leaf places occur at fairly regular intervals, and that leaves never spring out between.

(a) Leaves grow at places where the stem is slightly thickened. These places are called *nodes*.

(b) The spaces between the nodes are called *internodes*.

2. Let the pupil count the number of nodes in his stem. Sometimes there is no lengthening out of the internode, and then the nodes are crowded together, looking like rings on the stem.

3. What signs of life are there now on the twigs? Buds. Notice where the buds grow, their size, shape and colour.

(a) The buds grow in the corner between the leaf and stem, above the leaf.

(b) Every bud has a leaf scar below it.

This position is called the axil of the leaf.

(c) Beech buds are long and sharp-pointed, pale brown in colour.

(d) Sycamore buds are short and thick, blunt-pointed, and greenish-grey in colour.

(e) Ash buds are black.

(f) Every bud is covered with overlapping scales.

4. A tree may be recognised by its buds as easily as by its leaves.



## THE WINTER SLEEP.

We thus see that many of our trees cast off their leaves and appear dead; but the living buds are there, and there is full life under the bark. The trees have gone to sleep for the winter. Like hedgehogs and squirrels, they hibernate, because the cold would be too severe for their leaves and tender shoots.

*Buds*, as we may see in spring, are young branches.

## LESSON XVIII.

## THORNS AND PRICKLES.

*Twigs of hawthorn, rose, gorse (furze) and bramble.*

## HAWTHORN AND ROSE.

1. The prickly nature of rose and hawthorn bushes is known to every boy, and there can be little doubt as to what purpose these prickles serve.

2. But let us see what they are. Let the pupil sketch carefully a very small twig of each plant, showing where the sharp points grow, and what they are like. He should then write down the chief things noticed.

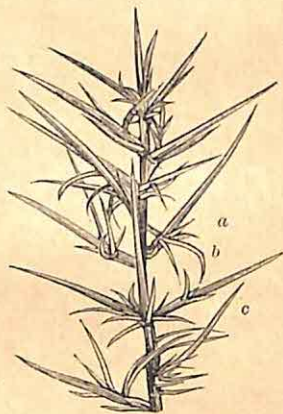
- (a) The sharp points on the rose are scattered about the stem.
  - (b) They also grow on the petiole and the backs of the principal ribs of the leaf.
  - (c) They are curved like hooks.
  - (d) They turn backwards, that is, the opposite way to that in which the stem is growing.
  - (e) The hawthorn points occur only in axils of leaves.
  - (f) They are longer and straighter than those of the rose.
  - (g) They are sometimes from two to three inches in length.
- Then we usually find small buds growing out of them.

3. It will thus be seen that we have two quite different forms of defensive points. Those of the rose are called *prickles*, but the others *spines* or *thorns*.

4. Clearly these do not arise in the same way. The rose prickles are hairs that have become very strong. But the hawthorn spines? What do they take the place of? Buds. And buds are young branches. To further confirm this notion, it may be noticed that the thorns when well grown bear leaves and even buds.



Fig. 42. Bramble Stem, showing prickles, which are modified hairs.



a Bud in Axil. b Leaf. c Spine.

Fig. 43. Stem of Gorse or Furze, bearing spines and leaves on them (natural size). The spines are altered branches.

## GORSE AND BRAMBLE.

1. Let these plants be observed as above. There will be no difficulty in arriving at the conclusions below:—

(a) The bramble is covered with prickles like the rose.

(b) The gorse has spiny branches or thorns like the hawthorn.

• 2. It may be added that gorse leaves are very narrow and sharp-pointed, and may almost be taken for spines. It is only when the gorse is a tiny seedling that it has a different leaf. Then it is three-lobed, like clover.

*Note.* Changes in the forms of organs, so that they come to serve other purposes, are called modifications. Thus:—

1. The hawthorn and blackthorn spines are modified branches.
2. The spines of the barberry are modified leaves, as can easily be seen.
3. The spines of the gooseberry are held to be special developments of the base of the petiole.

## LESSON XIX.

### ROOTS.

(1). *Roots of grass, dandelion, shepherd's purse, lesser celandine or dahlia.*

(2). *Experiments:—Some seeds for sowing—sunflower, mustard, wheat, broad beans. Two glasses (tumblers), small pots, soil.*

#### TWO CHIEF KINDS.

1. Compare grass roots with one like the carrot or dandelion.

(1). The dandelion has a strong root that goes straight down into the soil.

(2). The grass roots are a mass of fibres.

2. The one is a tapering or tap root, the latter are called fibrous.

3. Compare with these the dahlia or lesser celandine. These are called tuberous.

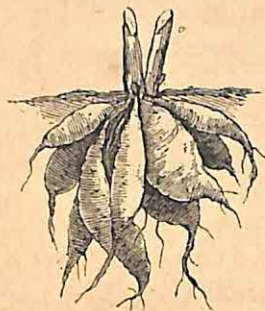


Fig. 44. Tuberous roots of the Dahlia.



## OBSERVATIONS ON ROOTS.

1. Sow seeds as in the following ways, and from time to time make notes of their progress :—

(1) Sunflower seeds in light soil. When the stem is two inches high take up the seedling and examine the root.

(2) Broad or Windsor beans (or kidney beans) in light damp sawdust or soil. Put part of them with broad end and part with the thinner end upwards. These should be examined when the stem is three or four inches high. By some arrangement with a glass the whole course of the growth of the root might be observed and the rate of it.

(3) Mustard seed in a tumbler, having first covered the tumbler with brown paper. A further quantity in an uncovered tumbler would increase the usefulness of the experiment.

(4) Wheat on cotton wool over water.

2. The following are some of the observations that should be made :—

(a) The root grows the opposite way to the stem.

(b) Even when the seed is inverted the stem grows upward and the root downwards.

(c) If a plant be placed horizontally the root tip turns downwards.

(d) Branches spring from all parts of the roots. There are no nodes.

(e) Roots shun the light.

(f) Roots become covered or felted over with a soft down.

These are called *root-hairs*.

3. A root therefore differs from a stem in having neither nodes nor leaves, in its mode of branching, and in the absence of buds.

## LESSON XX.

## SPRING'S AWAKENING : BUDS.

*Sycamore, beech, and horse-chestnut buds on twigs in spring in various stages of growth.*

## THE STRUCTURE OF A BUD.

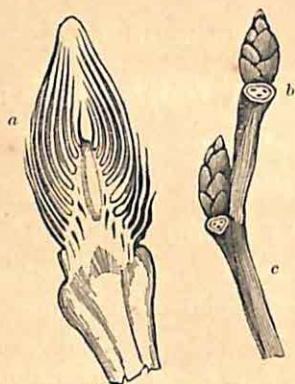
1. We talked of buds in autumn when the leaves fell, and now, after sleeping all winter, they are waking with the coming of spring. Wherever there is a bud, there was a leaf in the previous year, or at least immediately below it, for the position of the bud is the axil of a leaf, except in the case of terminal or end buds.

2. The best way to examine a bud is to watch its growth day by day, and sketch it as it gradually expands. The beech bud will do very well for treatment in this way. Let us take a sycamore bud, and observe:—

- (a) The sycamore bud is a large, almost egg-shaped bud.
- (b) Its scales are greenish dashed with pink.
- (c) They become as handsome as flowers as they unfold.

3. Take a bud and remove the scales carefully, beginning with the smallest at the base, and so on until the true leaves are reached.

- (a) The scales overlap one another like tiles on a roof.
- (b) There are about a dozen scales to cover each bud.
- (c) They are arranged in pairs.
- (d) After the scales, we come to small but ordinary five-pointed sycamore leaves.
- (e) In the very centre is the tip of the stem.



*a* Overlapping leaves. *b* Scar of fallen leaves. *c* Stem.

Fig. 45. Buds. One in section enlarged.

4. That is the growing point, and it is protected by the overlapping leaves. Each scale is also a modified leaf. The places where they grow are nodes, but how short are the internodes!

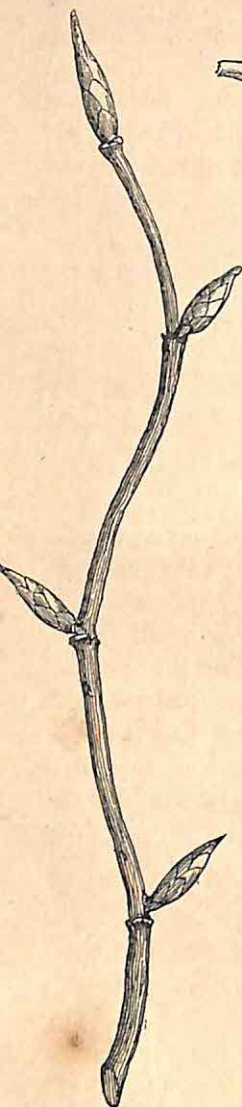
### BEECH BUDS.

1. If some of these are watched and sketched to illustrate their biographies, some interesting facts will be revealed, and a most useful means of observing encouraged.

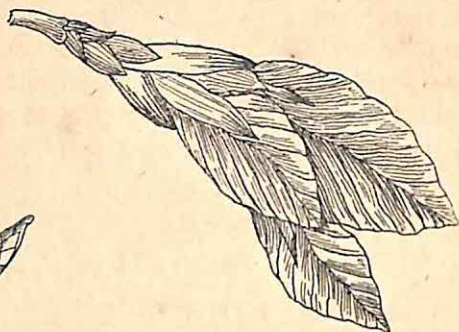
- (a) The green leaves gradually appear from amongst the brown scales.
- (b) This is caused by the lengthening of the stem which is inside the bud.
- (c) It is the internodes that gradually become longer.
- (d) There still remains a terminal bud ready to open out.
- (e) The new leaves are all on the new shoot.
- (f) This is a new branch.
- (g) The scales are in pairs at the bases of the new leaves.

2. This last fact shows us that the bud scales in the beech are *stipules*, modified to act as bud protectors, while in the sycamore the bud scales are modified leaves.

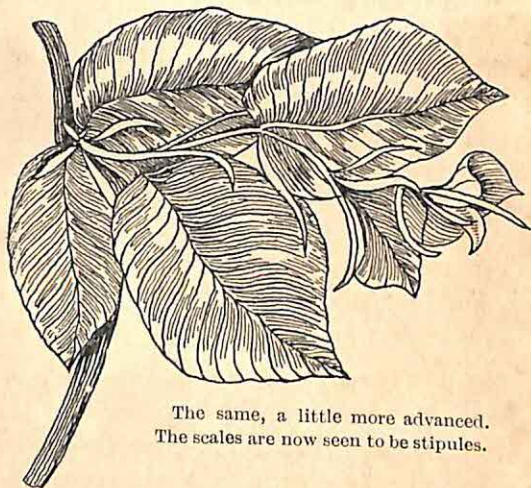




Buds in March.



The enlarging  
bud displays the  
young leaves,  
still partly cov-  
ered by the  
scales.



The same, a little more advanced.  
The scales are now seen to be stipules.

Fig. 45a. Beech buds.

## RESTING BUDS

1. In herbaceous plants (nettle, ragwort, etc.), the buds have no covering scales.
2. Where special scales are formed, the buds rest through the winter. Such then are called resting buds.
3. A cabbage in heart is a large bud of the first year. If left till the second the leaves open out.

## LESSON XXI.

## BULBS.

*Any bulbous plants grown to a fair size, and a few bulbs for observation.*

## WHAT IS A BULB?

1. There is a kind of lily which, like many other plants, produces buds in the axils of its leaves. But then happens an unusual thing. These buds begin to grow hard and solid through the thickening of their tiny leaves. Still more wonderful now, the buds drop off, and, falling on the ground, send out tiny roots, and eventually become new plants.

2. These buds are *bulbs*. Just as a young branch may be hardened and become a spine, so in the case of this lily, a bud becomes so modified that it may be detached like an autumn leaf and begin life on its own account.

## BULB STRUCTURE.

1. It is not in all cases so easy to see what the bulb really is, for most bulbs grow in the ground. Name some plants that have bulbs? Onion, snowdrop, blue-bell, hyacinth, daffodil.

2. An old hyacinth bulb is a good one to examine, for it has generally several secondary bulbs. Take one and cut it through. What do we see?

- (a) A small solid portion out of which roots grow (stem).
- (b) Many overlapping fleshy scales (leaves).
- (c) Young bulbs between some of the leaves (these are buds in the axils of the leaves).

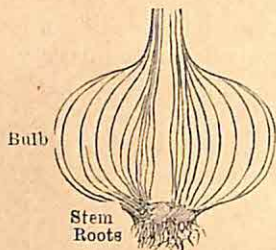


Fig. 46. Bulb of Onion, with stem and root.

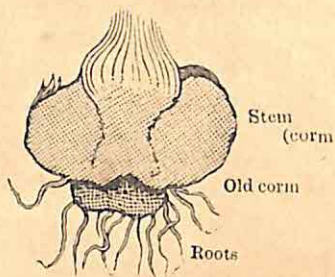


Fig. 47. Corm of Crocus.

### SOLID BULBS.

1. Crocus and gladiolus bulbs have a general resemblance to one of the bulbs spoken of above, but a section of one will show considerable difference. The best way to understand them is to grow them, and observe how new ones are formed.

2. Such are generally called solid bulbs, but in books they are called corms. They are formed by the thickening of the base of the stem, and do not appear as buds in axils of leaves.

### QUESTIONS.

1. Why is it possible to grow a bulb in water alone?
2. Is a bulb a seed?



## LESSON XXII.

### CLIMBERS.

*Vetch, cucumber, hop, scarlet runner, bindweed, ivy.*

#### THE SCARLET RUNNER.

1. Name some plants that raise themselves by the help of others.

2. Let us consider the scarlet runner. Why is it so called?

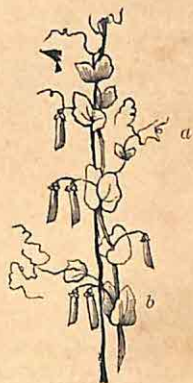
(a) "Runner" because it climbs up quickly.

(b) "Scarlet" on account of the colour of its flowers.

3. But how does it climb? This can be observed if specimens are at hand attached to the sticks, or if you plant some seeds, and as they grow observe them. Perhaps those suggested for Lesson XIX. may be ready.



Fig. 48. Twining stem of Hop. (N.B.—Follow the direction of the stem; it always turns to the right.)



a Tendrils. b Large stipules.  
Fig. 49. Stem of Pea, bearing leaves, tendrils, and fruit.

4. This mode of climbing we may call *twining*. Other examples - are furnished by the hop and bindweed.

### THE VETCH.

1. If a pea plant cannot be seen in the garden, a vetch can usually be found in some hedgerow. Examine the leaves.

(a) The vetch leaf is compound of 8 or 10 leaflets.

(b) Several of the end ones are twisty things, as if they were only midribs.

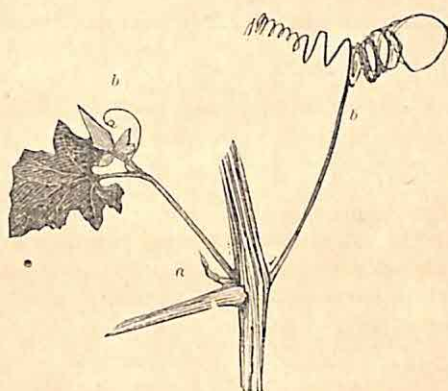
(c) They twist round sticks, twigs, bits of grass, or anything they touch.

2. These things are called tendrils. They are modified leaflets.

3. Tendrils occur on cucumbers, white bryony and other plants of that family (see Fig. 51). In that case a whole leaf becomes a tendril.



Fig. 50. Portion of compound leaf of Vetch. The last three leaflets are unformed, their midribs being developed as tendrils (natural size).



a Axil of leaf. b Tendril. c Node.

Fig. 51. Tendrils of White Bryony. One large leaf has been removed (natural size).

### QUESTIONS.

1. Why should plants climb?
2. What would happen to a scarlet runner if it could obtain no support?
3. Make a list of all plants you can find that climb, and say whether by tendrils or twining.
4. How does ivy climb? (By small roots).
5. A vine has tendrils, which branch out and often produce flowers. Of what do you suppose they are altered forms? (Branches).
6. To grow scarlet runners what seed must we sow?
7. What kind of a stick does a scarlet runner need? Why?
8. Why should sticks for peas be different?

### LESSON XXIII.

### STEMS: CREEPING AND BURROWING.

(1) *Strawberry* or *silverweed* or *creeping crowfoot*; (2) *coltsfoot*, *mint*, *raspberry*, or *iris*; (3) *some well-sprouted potatoes*, or a "root" about half grown.



## RUNNERS.

### 1. Examine runners of strawberry.

- (a) The stem is long and too weak to hold itself upright in the least.
- (b) At its nodes are leaves.
- (c) Wherever a node has been in touch with the ground, young roots have shot out.
- (d) New plants are formed in this way.

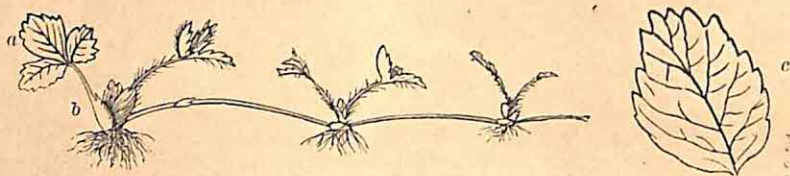


Fig. 52. Runner or running stem of strawberry, rooting at the nodes.

2. Plants like this find it an advantage to them to spread over the ground quickly and establish many stations, rather than climb up others like those we talked of in the last lesson.

## BURROWING.

1. Take a coltsfoot or mint well up, and you will find long horizontal growths. Notice:—

- (a) These long shoots have nodes with small scales (representing leaves).
- (b) At the tip there is a distinct bud.

2. From what we said of roots in a previous lesson we have enough evidence here to show us these are not roots. They are stems that burrow in the ground, and being somewhat like roots are called *rhizomes*.



*a* Node. *b* Underground stem or rhizome.  
*c* Roots.

Fig. 53. Underground stem (rhizome) and radical leaves of Valerian (*valeriana dioica*),  $\frac{3}{4}$  natural size.

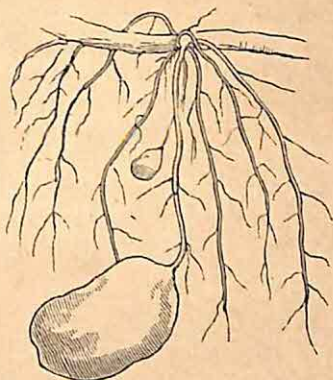


Fig. 53a. Underground stem (with tubers) and roots of Potato. The fine lines represent roots.

3. It is a great advantage to a plant to have a burrowing stem. It may spread freely in all directions below the surface, and though it may be destroyed above ground, there is always enough below to produce many new plants. Even digging only divides it. This is why it is difficult to get rid of some kinds of weeds—black bindweed, marsh woundwort, coltsfoot, and couch grass.

## A POTATO.

1. If a half-grown root can be examined it will be seen:—

- (a) The potatoes are on the ends of rhizomes.
- (b) The potatoes have "eyes."
- (c) Eyes are nodes, and contain young buds.

2. If some well-sprouted potatoes are seen, this will be easily understood. Such should be planted in pots and watched.

3. Such formations as these are called *tubers*.

## QUESTIONS.

1. Is a tuber a root or stem? Why?
2. Is it a seed?
3. For what purpose are tubers formed?
4. Give one instance each of a plant having its stem habit as follows:—
  - (a) Upright or erect stem.
  - (b) Prostrate stem.
  - (c) Ascending stem.
  - (d) Climbing stem.
  - (e) Running or creeping stem.
  - (f) Rhizome or burrowing stem.
  - (g) Tuber.

## LESSON XXIV.

## CLASSIFICATION.

*Specimens of animal, vegetable, and mineral; woody and herbaceous stems; oak leaves and holly or ivy leaves; a marigold plant, a cabbage, turnip, or carrot.*

## THREE KINGDOMS.

1. Consider the differences between a piece of sandstone, a plant, and an animal. It will be observed:—
  - (a) An animal has life, and can move of its own will from place to place.
  - (b) A plant has life, but cannot move from place to place; it can only grow from one place to another.
  - (c) The sandstone has no life, and cannot move or grow by its own power.



2. Everything we can think of on the earth belongs to one of these three classes or KINGDOMS, as we call them; the first is the *animal*, the second the *vegetable*, and the third the *mineral kingdom*.\*

### SIZE.

1. Plants themselves may be divided into classes; for if a plant grows tall, and has a woody stem, we call it a *tree*. Such are the *oak*, *ash*, *lime*, etc.

2. But there are many with woody stems not called trees; they are smaller; such are *hawthorn*, *gooseberry*, *currant*. They are called *shrubs*. Their stems are much branched, and not more than fifteen feet high.

3. Then we have a great number of plants whose stems are not woody, but herbaceous; they are less than trees, and often smaller than shrubs. These we call *herbs*. The word *herb* is popularly used for plants having certain medicinal or other properties, but in botany we use the term as above. A sunflower plant is a herb, the heather is a shrub.

### DURATION.

1. There is still another way in which we may classify plants. Suppose we think of the length of time a plant lives. Take a marigold. It grows up from a seed in the spring, flowers in the summer, and dies when the frosts of autumn come. So also do the sunflower, the shepherd's purse, and the groundsel. These live only one season or year, and so they are called *annuals*.

2. Some plants, like the cabbage, turnip, carrot, live two years, bearing their flowers in the second year. These are called *biennials*.

3. All others that live for a longer time are called *perennials*. Find examples of each of the above.

\* It is difficult to draw the boundary line between the animal and vegetable kingdoms, but a more correct distinction than the one in the text is this, that a plant has the power of assimilating inorganic matter, and so converting it into organic, while no animal has such power.

**SUMMARY.**

Plants belong to the Vegetable Kingdom, and we can classify them in three ways :—

1. If we think of their size and kind of stem, they are :—

- (a) Trees, or
- (b) Shrubs, or
- (c) Herbs.

2. If we think of how long they keep their leaves, we have :—

- (a) Deciduous plants, or those with deciduous leaves.
- (b) Evergreen plants.

3. If we think of the length of time they live, we have :—

- (a) Annuals.
  - (b) Biennials.
  - (c) Perennials.
-

## COMPLETE SCHEDULES.

## I. ROOT.

|      |                                  |
|------|----------------------------------|
| Kind | Fibrous, tapering, or tuberous ? |
|------|----------------------------------|

## II. STEM.

|            |                                                                                              |
|------------|----------------------------------------------------------------------------------------------|
| Appendages | Leaves, flowers, fruit, prickles, spines, or tendrils ?                                      |
| Kind       | Woody or herbaceous ? Solid or hollow ?                                                      |
| Shape      | Angular, round, or winged ?                                                                  |
| Habit      | Tree, shrub, or herb ? Rhizome, bulb, or tuber ?<br>Erect, ascending, running, or climbing ? |
| Duration   | Annual, biennial, or perennial ?                                                             |
| Leaves     | Deciduous or evergreen ?                                                                     |
| Surface    | Hairy, downy, cottony, or glabrous ?                                                         |
| Colour     | Red, green, or what ?                                                                        |

## III. LEAF.

|             |                                                                                                                                           |
|-------------|-------------------------------------------------------------------------------------------------------------------------------------------|
| Position    | Radical or cauline ?                                                                                                                      |
| Insertion   | Petiolate or sessile ? Stipulate or exstipulate ?                                                                                         |
| Arrangement | Alternate, opposite, or whorled ?                                                                                                         |
| Venation    | Net or parallel ? Palmate or pinnate ?                                                                                                    |
| Margin      | Entire, serrate, dentate, crenate, spiny or lobed ?<br>If lobed, whether pinnatifid, runcinate, or<br>lyrate ? Palmatifid or laciniate ?  |
| Composition | Simple or compound ? Pinnate, or digitate ?                                                                                               |
| Apex        | Obtuse, acute, or acuminate ?                                                                                                             |
| Base        | Obtuse, acute, or lobed.                                                                                                                  |
| Shape       | Round, elliptical, oblong or linear ? Ovate,<br>cordate, lanceolate, kidney or awl-shaped ?<br>Obovate, obcordate or oblanceolate, etc. ? |
| Surface     | Hairy, downy, cottony, or glabrous ?                                                                                                      |
| Colour      | Green, white, etc. ?                                                                                                                      |



## LESSON XXV.

## NEW PLANTS FROM OLD.

*A few stems of mint, hawthorn, or other easily-grown plant; tubers, bulb, corm; strawberry runner; germinated wheat, peas, beans, apple pips, radish or mustard seeds (these should be sown on cotton wool or wadding, on the top of water, a week before they are wanted).*

## CUTTINGS.

1. Nearly every one has seen a plant grown by cutting off a piece of stem and fixing it in the soil. Let us see how this is done.

2. Recall what we learnt of the strawberry runner:—

- (a) The stem runs or creeps off the ground.
- (b) Roots grow down at some of the nodes.
- (c) New plants are formed, and may be separated from the old ones.

3. Something very much like this takes place when a *cutting* is made. A branch or piece of stem is cut off when in healthy growth. Leaves and buds are stripped from the lower nodes. The branch is then carefully planted in the soil three or four nodes deep, and from these nodes roots grow. Thus a new plant is produced. Try the experiment with mint.

## TUBERS, ETC.

1. Let us recall what we discovered about the tuber of a potato.

- (a) The tuber is a thickened end of an underground stem.
- (b) The "eyes" are nodes.
- (c) In the "eyes" are buds.

2. Now, if we place this tuber in moist warm soil, what happens? It begins to grow. Stems shoot out from their eyes; from their lower nodes roots grow; from their upper ones, which appear above the ground, leaves spread out. Thus we have another plant in all respects like the one from which the tuber was taken. A tuber is a natural "cutting," given off by the plant itself.

3. Take an onion or snowdrop bulb, and a crocus corm; these produce new plants in a similar way. They are really buds. Like the tuber, they are given off for the same purpose that a *cutting* is taken, but they have this great advantage, that they can be kept months and even years before they are planted. Let us see why.

4. Suppose we keep a cutting and a potato on a shelf for a week, in what state are they?

- (a) The cutting is dried up and withered, in fact, dead.
- (b) The potato is full of moisture.

Tubers, bulbs, and corms are thus formed that they can be kept out of the ground, and still grow when suitably placed.

### SEEDS.

1. Every pupil should examine as many of the germinated seeds suggested at the head of this lesson as possible.

Take first a grain of wheat, and notice :—

- (a) A part of the grain has begun to grow.
- (b) This part can be taken off.
- (c) The greater part of the grain is left (in shape), but it is soft, and seems to contain less matter.
- (d) The growing part has a little root and a stem, on which are leaves.
- (e) It is therefore a little plant.

We see then that from a seed grows a little plant. If we examine some half-ripe mustard or radish seeds, we shall clearly see the little plants curled up inside.

2. Look for the little plant in the other germinated seeds, and observe the parts. It should also be noticed that warmth and moisture have been necessary to make the seeds grow.

### SUMMARY.

Plants—new ones in place of old ones—may be grown from :—

- (a) Cuttings of stems carefully fixed in the soil.
- (b) Bulbs, corms, tubers, which are given off by the old plant for the purpose. Tubers are pieces of stem, and bulbs and corms are buds.
- (c) Seeds which contain each a little plant, given off in this way for the purpose.

## LESSON XXVI.

## TRANSPIRATION.

*Two days before this lesson is to be given, take three complete plants freshly withdrawn from the earth, and, in view of the class, dispose of them as follows—pass the roots of No. 2 through a slit in a piece of cardboard, and allow the stem and leaves to dip into a jar of water, the root being kept entirely out by the cardboard. Treat No. 3 similarly, but place the root in water; then invert a tumbler over each, and set in the sunlight.*

## OBSERVATIONS AND INFERENCES.

1. Let us see what has happened to our plants :—

- (a) The first is withered and dead.
- (b) The second remains quite fresh.
- (c) The third is also fresh.

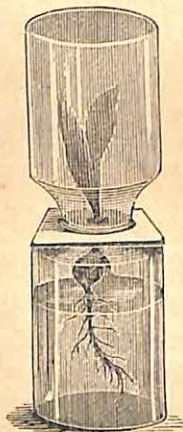


Fig. 54. Experiment to demonstrate transpiration (No. 3.)

2. Examine the inverted jars :—

- (a) The jar over No. 3 is covered with water inside.
- (b) The jar over No. 2 is quite dry.
- (c) The water must have come from the leaves and through the plant from the jar below.
- (d) Water then travels through a plant from root to leaves, but not from leaves to root.



3. This water has come from the plant in the form of vapour, and under the influence of the light. The hotter and drier the air, the greater is the quantity of vapour given off. But consider what would be the condition of the leaves if nothing happened but the "giving off" of water. They would soon become withered. Look at our first specimen.

- (a) Specimen 3 has remained fresh, because its root has been in water.
- (b) Water must have passed into its leaves from its roots, as fast as water was evaporated from them.
- (c) Specimen 1 has lost its water in the same way, and has had none to replace it; it has therefore become withered.
- (d) Light and heat cause a plant to lose its water more freely.
- (e) Therefore the greater the heat and light of the sun, the more water will a plant require.

4. As the water comes out of a plant, there must be openings by which it can pass out. These are in the leaves, chiefly on the lower side. They are small "mouths," and are very numerous. On a square inch of the under side of a lilac leaf, there are as many as 160,000.

5. This passage of water out of the leaves is called *transpiration*.

## EFFECTS OF TRANSPIRATION.

1. It is necessary for the growth of the plant that transpiration should go on. Water is taken up by the *root-hairs*; it mingles with the sap, and travels up the stem into the leaves. As it does so, some of it is evaporated in the way above described, and the sap becomes thicker the higher it rises in the plant. Besides this, material to make the plant larger is formed, as will be explained in a later lesson, and the water which is not needed is given off through the mouths and evaporated. So, as the plant grows, transpiration must go on.

2. But think what will happen if the air is too dry and the roots cannot keep the leaves supplied. The leaves droop and wither. Often when a plant has been removed, its leaves and

top hang down, and it is some time before it recovers. How could we prevent this? There are two ways :—

- (a) Supply water to the roots, or
- (b) Prevent evaporation from the leaves.

But in such cases the roots are often injured, and cannot at once take up the water; then we must prevent evaporation. How can this be done? Think of the conditions under which the water was obtained on the sides of the jar in our third experiment :—

- (a) We must keep the light from the plant, or
- (b) Stop up the little mouths in the leaves.

3. Look at the second specimen. Why has it remained fresh? No water has been taken up by its roots. But has the other process taken place?

- (a) Specimen 2 has received no water by its roots.
- (b) But no evaporation can have taken place, because the leaves have been in the water.
- (c) The water has stopped the little mouths, and prevented transpiration.
- (d) So, although the plant has remained fresh, no growth could take place.

4. We may thus infer the effect of wetting leaves :—

- (a) Dust is cleared off, and the process of transpiration assisted.
- (b) But a continuous covering of water would be injurious by preventing transpiration.

5. Ferns grown in glass cases are much fresher than those grown in the air of ordinary rooms. The glass case keeps in the moisture; the air about the leaves becomes moist, and hence evaporation is not too rapid. Besides this, the water runs down the glass and moistens the soil again.

6. Large plantations of trees give out great quantities of vapour, which moisten the atmosphere. The cutting down of such plantations has often reduced the rainfall of a district.

## SUMMARY.

1. The leaves of plants in the light are continually giving off water. This is called transpiration.

2. The roots must take up sufficient water to supply the plant, and to make up for what is lost by transpiration.



3. If the roots cannot do this, the leaves droop, wither, and die.
4. The leaves do not take in water, but water washes away the dust.
5. Leaves are kept fresh in water, because no transpiration can take place.
6. Transpiration is reduced by keeping plants in the dark. In this way young plants may be kept from drooping, whilst taking root in new soil.

## LESSON XXVII.

### WHAT PLANTS ARE MADE OF.

*Some green specimens, a fire and an iron shovel; charcoal; glass jars full of water; some saltpetre.*

#### CARBON.

1. Our object in this lesson is to find out what plants are made of. Take some green specimens, weigh them, and dry them before the fire. Now place them on an iron shovel, and hold them over the fire. Keep moving them to prevent them from burning. Observe:—

- (a) Vapour is driven off by the heat of the fire.
- (b) This vapour is from the water contained in the plant.
- (c) As the plant dries it becomes *black*.
- (d) The plant has been dried, not burnt.

2. We thus find that when all the water is driven out of a plant, it is a black mass retaining its living shape.

3. Compare it with a piece of wood charcoal. This is a piece of a branch of a tree that has been similarly treated. It consists of a black mass called *carbon*. Pure carbon is in the form of a powder. The black charred mass left of our plant is carbon.

#### CARBON—ASH—WATER.

1. Weigh the black remains of the dried specimens. We shall find that they have lost more than half their weight. Hence we may conclude:—

- (a) A plant contains carbon and water.
- (b) More than half its weight is water.



2. Now apply a lighted match to the black remains. They burn very readily, and a small quantity of white ash is left. The carbon has disappeared, or taken another form. What that is, we shall see in the next lesson. For the present, we see that a plant consists of :—

(a) Carbon.

(b) Water.

(c) Ash.

## NITROGEN.

1. If, then, the above are the only things contained in a plant, they must be all that a plant needs to keep it in growth. But this is not so. If a plant be placed with its root in water, it will live and grow, but it will not produce flowers and fruit.

2. If a little nitrogen be added to the water, the plant may be grown to flowering and fruiting. Nitrogen is a gas. The air is composed largely of it. It exists in saltpetre. Dissolve a little saltpetre, and add it to the water. Leave two specimens, one in water only; the other in the water containing nitrogen, and observe the results. This experiment needs great care, too much saltpetre is fatal.

## LESSON XXVIII.

### THE FOOD OF PLANTS.

*Piece of charcoal, lime water, water, piece of glass tubing.*

#### WATER—SOLUTION.

1. In the last lesson we found that a plant requires :—

(a) Water.

(b) Carbon.

(c) Nitrogen.

2. In this lesson we are going to consider how a plant takes the food it needs. In the last two lessons we have seen :—

(a) Water is absorbed or taken up by the roots.

(b) Nitrogen may be taken up in the water.

3. The nitrogen was dissolved in the water. When we put a solid (sugar, salt, etc.) into a liquid, and it disappears, it is said to be dissolved. It has become separated into parts too small to be seen, and these have spread throughout the liquid. We know the solid is present, for we can test this by tasting, *e.g.*, sugar in tea. When a substance is dissolved, we say that we have a *solution* of it. If all the water is evaporated, the dissolved substance will be left. Try this with a solution of salt.

4. We then conclude, that nitrogen is in solution when taken up by the roots of a plant. There are some other substances of which the plant needs small quantities, and they are taken in the same way. These all exist in the soil; water dissolves them, and the roots absorb them in solution.

### CARBON.

1. We have said nothing yet of the manner in which a plant takes its carbon. Try to dissolve a piece of carbon in water. It will be found to be insoluble. Hence it cannot be absorbed like nitrogen.

2. We have spoken of nitrogen as forming a large part of the air we breathe; the other part consists of another gas called *oxygen*. We could not live by breathing nitrogen alone; we need oxygen. When a fire burns, it is the union of carbon and oxygen that causes light and heat.

3. Burn a piece of charcoal in a jar. The carbon disappears. It has united with oxygen, and the two are now in the form of a gas. After a short time pour a little lime water into the jar, and shake. It becomes of a milky colour. The gas just formed has changed its colour. This gas, because it is made of carbon and oxygen, is called carbon di-oxide.

4. Pour a small quantity of lime water into a bottle. With the aid of a glass tube blow into the lime water; it will in time become milky. Here again we have carbon di-oxide, for this is a certain test for it. Thus :—

(a) Carbon di-oxide is formed when a fire burns.

(b) It is in the air we breathe out of our lungs



5. By drawing air through the lime water, or forcing it through by means of a bellows, we should see that no milky colour is produced, so that the air before being breathed does not contain carbon di-oxide, at least not enough to be thus perceived. Nearly all our food (bread, potatoes, etc.) contains carbon.

6. Animals and fires are continually filling the air with this gas; a gas so injurious to us, that if we were to breathe it for a long time, we should be ill, and eventually die. It is poisonous to us. That is why we have ventilators in schools and public buildings. The carbon di-oxide must be got rid of, and fresh air introduced to take its place.

7. But this carbon di-oxide is just what plants need. It is in this form that they take their carbon. The under surface of every leaf is covered with numerous little holes or mouths, and all the day these are taking in carbon di-oxide, from which the plant gets the carbon it requires, returning the pure oxygen to the atmosphere again. Thus plants purify the air for us.

#### SUMMARY.

1. Plants take water and soluble substances by their roots.
  2. Carbon is insoluble and is not taken in this way.
  3. When animals breathe, or fires burn, carbon di-oxide is formed of oxygen and carbon.
  4. Carbon di-oxide is to animals a poisonous gas.
  5. Plants take in carbon di-oxide through their leaves.
  6. They retain the carbon, and return the oxygen to the atmosphere.
  7. Plants thus act as purifiers of the air.
- N.B. Nitrogen is only taken in the way described in the lesson, except in special cases, as in the so-called carnivorous plants.
-



## LESSON XXIX.

## MAKING UP THE FOOD.

(ASSIMILATION.)

*Some green leaves gathered in the afternoon (turnip or primrose); a little dry and some boiled starch; a small quantity of solution of iodine; some alcohol (methylated spirit); a potato, a grater, a sieve, water; a saucepan.*

## STARCH IN A POTATO.

1. Let us cut a potato, and rub it on a grater into a basin of water. Strain through a fine sieve into a glass vessel. Notice :—

(a) The water is full of something, which gives it a slightly milky appearance.

(b) Soon small particles fall as a sediment.

2. Pour the water and sediment into a saucepan and boil; the liquid becomes a thick syrup or paste. Now pour out, wash the saucepan, and boil a little starch in water :—

(a) The potato sediment when boiled becomes a thick pasty or syrupy liquid.

(b) Boiled starch is a similar liquid.

3. Take a little dilute solution of iodine and add a few drops to the starch; then to the boiled potato water :—*Both are turned blue.*

This is what always happens when iodine is added to boiled starch; and the blue colour is produced by iodine only when boiled starch is present. It is therefore a sure way of testing the presence of starch. What therefore may we know about the potato? It contains a large quantity of starch.

4. The white sediment is the starch. It is often extracted from potatoes as well as from rice, maize, etc. If we were to scrape off a little of the potato and place it under a microscope, we should be able to see very plainly little grains of starch, made up in layers like tiny shells. All plants contain some starch.

## THE MAKING OF STARCH.

1. Now as a plant does not take starch from the ground or from the air, and there is no other way of taking its food, the starch must be made within the plant.

2. A chemist could tell us that starch is made up of:—

(a) Carbon ;

(b) The substances of which water is formed ;

that is, simply of carbon and water. But simple as this may seem, no man has been able to make starch. It is only in plants that it can be made, and then only under two conditions :—

(a) In green plants.

(b) In the daylight, *i.e.*, the sunlight.

3. Now what part of a plant is greenest? *The leaves.* And what part is able to catch the most light? *The leaves.* And it is in the leaves that the starch is made. Leaves are *starch* factories, and by the aid of the sunlight, the water from the roots is all the day through joining with the carbon which the leaves are taking in from the air and producing starch.

4. If we cut up a few green leaves, and pour on them a little alcohol, we can extract the greenness, leaving the leaves quite pale. This is the colour of the leaves of a plant grown in the dark. This greenness or green colouring matter, which is called *chlorophyll*, in some way assists in the formation of the starch.

Carbon and water } aided by the { in the presence of } become—Starch in  
                          } sunlight { chlorophyll } the leaves of plants.

## STARCH PRESENT IN LEAVES.

1. If starch is made in leaves, we might surely expect to find it there. But we must have some way of detecting its presence.

2. Recall what we noticed of the starch obtained from the potato. It formed a sediment. We mix some starch in cold water ; observe the result. It is not dissolved, but forms a sediment. But when boiled this is not the case ; it is then dissolved.

3. We will use the iodine test to find out whether there is any starch in some green leaves, as follows :—



Boil the leaves to dissolve the starch (if there be any). Pour off the water, and add alcohol to take out the chlorophyll, for the green would hide the blue. When the leaves are of a pale yellow, add a little iodine solution.

If any blue appears, there is starch in the leaves. We must not expect to find a great quantity of starch.

### STORAGE OF STARCH.

1. As the starch is made, it is conveyed from the leaves to various parts, where it is needed to enlarge the plant, or to make it grow. There it is changed into other substances.

2. As the starch making can only go on in the day, the starch carrying goes on in the night.

3. The starch is not always all used up; many plants keep a store for future use—the turnip and carrot in their large roots, the potato in its tuber, and most plants in their seeds.

## LESSON XXX.

### ORGANS & THEIR WORK.

#### AN ORGAN.

1. There are certain parts of the bodies of animals which have some special work to do: for instance, eyes for seeing, nose for smelling, ears for hearing. Such parts are called *organs*. The ears are the organs of hearing.

2. Now just in the same way there are parts of plants having some special work to do.

#### PLANT ORGANS.

1. Think of what we have learned takes place inside the plant.

(a) The roots take up water.

(b) The stem carries the water to the leaves.

(c) The leaves breathe out water, take in carbon di-oxide; and starch is made in them.



2. We may therefore say, that roots, stems, and leaves are organs :—

- (a) Roots are organs of absorption.
- (b) Stems are transporting or carrying organs.
- (c) Leaves are breathing and building organs.

### SPECIAL ORGANS.

1. Now think of a turnip. What makes the root so large? Starch is stored up in it. This starch would all be used up in the plant's second year of growth, and so go to makê, stem, flowers, and seeds. The root is, in the meantime, used as a storehouse. Such a root may become then a place of storage.

- (a) Turnip, carrot, and parsnip roots are places of storage.
- (b) The tubers of potatoes are likewise places of storage.
- (c) Bulbs of onions are places of storage.

2. We can now easily recall some other parts of plants that have become set apart to do some special work :—

- (a) Thorns and prickles are organs of defence.
- (b) Tendrils are climbing organs.

3. The use of flowers and fruits we shall learn about in a later lesson.

### EXERCISE.

*Make schedule of root, stem, and leaves of various specimens of green plants.*

---

## LESSON XXXI.

## LEAVES AND SUNLIGHT.

*Some simple and compound leaves, cactus plant (or picture).*

## HOW LEAVES SEEK SUNLIGHT.

1. Let us recall what we found took place inside leaves of plants.

- (a) Starch is made.
- (b) This is done by means of the green matter—chlorophyll.
- (c) It can only take place in the sunlight.

We may therefore conclude that it is very necessary for leaves to grow in such a way that the sunlight may reach them.

2. Let us notice some of the ways by which this end is gained.

- (a) Some plants grow tall and spread out their leaves above all others. Such are trees.
- (b) Some plants, like the dock, the rhubarb, etc., have very large spreading leaves.

3. But consider some of the more slender plants :—

- (a) Some carry up their leaves by climbing up other plants: the hop, kidney bean, black bryony, etc.
- (b) Others spread all over the ground, *e.g.*, grass.

4. Consider again how closely crowded together the leaves of many trees are, or how dense the leaf masses where many plants grow together, as in hedges; how does the sunlight penetrate to all these leaves? Think of the size of the leaves of large trees. They are generally small, and easily moved by even light breezes. Then the leaves of plants that grow in dense masses in hedges and such places; think of some examples:—Hogweed, hemlock, angelica, etc.; what kind of leaves have these? Compound, or much divided leaves. The sunlight is thus able to penetrate through these masses of foliage. We may therefore conclude :—

- (a) The smallness of the leaves of very large trees is a means of admitting sunlight to all their leaves.
- (b) Compound, or divided leaves, allow the light to pass through.
- (c) It is therefore more to the advantage of a plant, that if it is large or is crowded amongst others, its leaves should either be small or much divided.

### THE PENALTY PAID.

1. Now, if sunlight has access to leaves, something besides the taking in of carbon di-oxide happens. You will remember our experiment with the plant under the glass, water was evaporated or breathed out of the leaves. And of course it is easily seen that the more the sun shines on leaves, the more water will be evaporated from them. Hence, if a tree has many leaves, it will need a good supply of water to keep pace with the evaporation, and prevent the plant from drooping and dying. So what does a plant with great leaf surface also need? Many roots. The roots must extend in proportion to the leaf surface.

2. In dry countries, then, a tree will have great difficulty in keeping up its water supply, for the evaporation will be very great. It must either:—

- (a) Grow enormous roots, or
- (b) Have few leaves.

3. Yet there are two other ways of meeting the difficulty. In Australia, which is subject at times to great droughts, there are trees which, instead of spreading out the flat surface of the leaf, as ours do, only turn the edge of the leaf to the sun, and so get the required amount of sunlight without losing so much water by evaporation as they otherwise would. In Mexico, the cactus has no real leaves, but only very thick stems, which retain moisture for very long periods.

### SUMMARY.

1. Leaves require sunlight, so that the work of building up the plant may be carried on.



2. The leaves of a plant must then be exposed to the sunlight as much as possible. This is gained :—

- (a) By trees being tall.
- (b) By climbing over others.
- (c) By spreading over the ground.
- (d) By having small, or much divided leaves between which the sunlight can enter to those below.

3. The more exposed leaves are, the more the plant suffers from excessive evaporation. This is compensated for :—

- (a) By very extensive roots.
- (b) By the edge of the leaf being towards the sun.
- (c) By having very thick succulent stems or leaves.

## LESSON XXXII.

### PROTECTION.

*Holly, thistle, bramble, rose, coltsfoot, dock, speedwell.*

#### DEFENCE AGAINST ATTACK.

1. We know that cattle are fond of eating, not only grass, but many kinds of plants. They often bite off young shoots. We can easily imagine what a cow would do if she got a mouthful of prickly leaves. You may have seen a cow bite off a thistle.

2. What service then do these prickles perform for a plant? Think what would happen to such a plant if it had no prickles. It would be very much eaten and injured; as it is, it is left alone.

3. All plants are not suited to the taste of animals, and do not need this defence. But some, such as the holly, are especially liable to attack; and we generally find that the lowest leaves are the most prickly, those too high to be reached having almost entire margins.

**DRAINAGE.**

1. We have seen in a previous lesson, that leaves have little mouths through which to take in carbon di-oxide. Now, if leaves become covered with dust, what are the consequences ?

(a) Carbon di-oxide cannot be received.

(b) The growth of the plant is impeded.

Hence the need for washing the leaves. This is effected by the rain.

2. But in Lesson XXVI. we found that water is also given out from the leaves, and that if they were under water, this could not freely take place. That is to say, there would be no evaporation from the leaves, and water would thus cease to flow up the plant. So it is not well that the leaves should be continually wet, unless specially suited, as in the case of some water plants.

3. Take two leaves, one having a smooth even surface, with entire margin, and the other an uneven surface with an irregular margin. Wet these leaves, incline them, and notice which dries in the shorter time. It will be found that in the latter case the small grooves act as drains, and the points in the margin assist the water to drop off the leaf.

4. Take a hairy and a glabrous leaf. Dip both in water. The water scarcely wets the hairy leaf. Hence it will be seen that:—

(a) The hairs keep the leaf from becoming too wet.

(b) They will also serve to keep off dust.

5. The following characters may then be taken to be useful to a plant, to assist in the drainage of water from its leaves.

(a) Spines on the margins of the leaf.

(b) Hairs on the surface.

(c) Uneven surfaces of leaves.

(d) Grooved petiole in cases where the apex of the blade is directed upwards, *e.g.*, dock.

(e) Angular stems.

(f) Lines of hair on the stems, *e.g.*, speedwell.

**CONCLUSION.**

We may thus conclude that all the characters of a plant exist for some special purpose. Some of these we have found out in these lessons; some we shall study in later lessons; and some are not yet properly understood by any one. But none have been discovered without careful observation and patient study. So you will see why you should observe so carefully and accurately every little detail of every part of a plant.

**QUESTIONS** (to be answered in writing).

1. What parts of a plant are used as food in the following:—  
Cabbage, rhubarb, potato, carrot, onion.
2. Describe an oak tree.
3. Compare a horse-chestnut leaf with a Spanish chestnut leaf.
4. Why does an oak tree do better with small leaves than it would with large ones like rhubarb leaves?
5. Why do plants drop when moved from the soil and put into fresh ground? What would be the best way to prevent the drooping?
6. Why do plants need their leaves to be brought to the sunlight?
7. Examine privet bushes and notice how they get as much leaf surface as possible exposed to the light.
8. Observe some young seedling, and keep a daily record of its growth. Measure its chief internodes by marking their positions on a stick set by the side of the plant.

END OF SECTION I.



SECTION II.

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FLOWERS.

## NOTE ON APPARATUS.

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THE note at the beginning of the previous section applies in the main to this section with, if possible, even greater force. Some little additional apparatus is necessary. It would be decidedly advantageous that each pupil should have a *sharp knife* and a *mounted needle*; but these are by no means absolutely necessary; an ordinary clean steel pen in a holder forms a workable substitute.

A *magnifying glass* for each one is also a very useful addition, such for instance as may be bought for threepence or sixpence each, but those commonly sold at a penny will meet all the needs as suggested in the lessons of this section.

An *alternative* arrangement is to provide better glasses mounted on feet, to stand on a table, at the rate of, say, one for every ten pupils. Such may be bought at prices varying from eighteen-pence to half-a-crown. To get the best use out of them it may be suggested that the teacher should prepare the specimen for one glass in the presence of his pupils, and that the requisite number of pupils should prepare objects for the others. Three

or four minutes would then suffice for observation by the whole class. This plan gives clearer and bolder objects for observation, but it does not provide for every pupil *habitually* using his own glass.

Yet plenty of interesting and useful work can be found, not merely for one or even two years, without the use of a lens at all. There is plenty for the ready eye, if attention is directed to the growth of plants, their habits, their associates, and general life histories, noticing them not once but again and again as the seasons come round, the insects that visit them, the soil and kind of ground in which they grow. There is more to be learnt from naked-eye observation than can be encompassed by the average child during his school days.

*Diagrams and plates* are a great aid in generalizing or bringing out minute characters. But they should not, as a rule, be used until *after* acquaintance has been made with what they represent. Progress is greatly interfered with where the pupil finds that the natural object requires much more care and patience to observe than the artificial diagram; and you thus "study nature indoors, and when you go outside you cannot find her."

*Dried Specimens v. Nature Studies.* In former editions a note was added about the use of dried specimens. As I no longer believe in them I have taken out the note. In the first place I do not think it desirable to encourage large numbers of children to collect wild plants for pressing. There is first the raid on the wild plants, secondly a great mass of awkward material to deal with, and lastly, what becomes of it in the end? If a single collection is made for the school,



that is not open to objection, assuming rare species (should the district possess any) are excluded.

I have found it much better and more interesting to make nature studies in water colour of the plants dealt with each lesson. The teacher must gather or superintend the gathering, and one specimen may serve two, or even four children, if seating is suitable.

As to winter work, we have now a fair supply of flowers from bulbous plants, but lessons on the physiology of plant-life, such as those in the last section or in Book III, which contains much matter suitable for all stages, may well fill up the time when flowers are few.

*Technical Terms.* In some of the following lessons there are perhaps a few more technicalities than are necessary unless a class is being taken on to Natural Orders. In that case there is but the minimum needed. "Placentation" and all that it means may be ignored except in such cases.

*Note on Lesson V.* The Willow Flowers ("Palms") are better than those of the oak for the purpose of the lesson. The staminate flowers grow on one tree and the pistillate on another. The former have two stamens to each flower, and the latter one pistil with two stigmas each. The seeds are interesting.

*Examining Flowers.* It is not well to let children acquire a habit of wantonly pulling flowers to pieces. On the contrary, everything should be done to foster a different spirit. Very often all that is wanted can be seen without the least act of destruction. For instance, a buttercup, wallflower, or blue-bell can be examined quite entire. It may then be

used for a nature drawing and kept in water until the next lesson. By that time the sepals, petals, and stamens will have fallen, leaving the carpels somewhat enlarged. The story of the flower is thus made to reveal itself, as it were, before the class.

I do not say a flower should never be dissected, but let it be done only when necessary.

Further, children should be discouraged from gathering more flowers than are needed. Let them learn to feel that wild flowers are never so beautiful as in their own wildernesses.

# OBJECT LESSONS

FROM

Forest, Field, Wayside, and Garden.

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## LESSON I.

### A PRIMROSE.

"A primrose by a river's brim,  
A yellow primrose was to him,  
And it was nothing more."

*Each pupil should have, at least, one flower. There should also be one specimen of the whole plant.*

#### GENERAL OBSERVATIONS.

1. We have been learning a great deal about the leaves of plants; now we must turn our attention to a very important and interesting part—the flowers. Everybody likes flowers, but few people understand how they are formed or why they grow on plants at all. We shall find that by careful observation we can learn more about them than we have already learnt about the leaves.

2. We will begin with a *primrose*. These flowers grow on a lowly plant; observe the specimen:—

- (a) The leaves of the primrose are all radical.
- (b) They are wrinkled, net-veined, and oblanceolate.
- (c) The flowers grow on slender stalks.
- (d) The flowers are pale yellow.

3. These plants are often grown in gardens, but in many places they are found wild, and a bank of primroses in *early spring* is a very pretty sight.



## EXAMINATION IN DETAIL.

1. Hold the flower by its stalk in your left hand. We have said its colour is pale yellow. But there is something not so coloured. Hold the yellow part downwards so as to be able to see what is below it. Examine carefully; each pupil should be able to state:—

(a) The upper part of the flower is yellow and spreading.

(b) Underneath this there is a green tube or *cup*.

2. There are then two parts:—the upper coloured and more noticeable part which we will call the *crown* of the flower, and the lower green cup-shaped part, which for the present we will call the *cup*.

3. Still holding the specimen by the stalk, let each with his right hand carefully take the crown between his finger and thumb, and pull it away from the cup. We have now to see what is to be found inside each of these parts.

4. Notice the shape of the crown. Slit the tube open and look inside. Observe:—

(a) The crown has a long narrow tube.

(b) Inside this tube are *five* small bodies.

(c) These bodies are covered with yellow dust. *They are called stamens.*

5. Now take up the *cup* of the flower. Notice its points—*five*. Slit down one side, or remove it altogether. Observe:—

(a) The *cup* has five points.

(b) When removed, a long body of a pale green colour is left standing at the end of the stalk. (*This is called the pistil. Notice its resemblance in shape to a pestle used by a chemist.*)

(c) The pistil is thick at the bottom, thin in the middle, and has a knob at the top.

## PARTS OF A PRIMROSE FLOWER.

1. Now let us write down the parts we have observed; which shall we take first? The *crown* is the most striking, but the *cup*

is outside it; so we will begin from the outside. Then comes the crown; notice now how many notches there are in its margin. As the stamens are fastened to the crown, we take them next. So the parts are:—

- (a) The green *Cup* with five points.
- (b) The yellow *Crown* with five notches.
- (c) The five *Stamens*.
- (d) The *Pistil*.

2. Do not think we have pulled these flowers to pieces for the sake of destroying them. Our object has been to learn what we could about them; that the flower might be to you something more than a yellow primrose.

If the first lesson be given in summer, when primroses cannot be obtained, the foxglove, harebell, or phlox would be the best as alternatives.

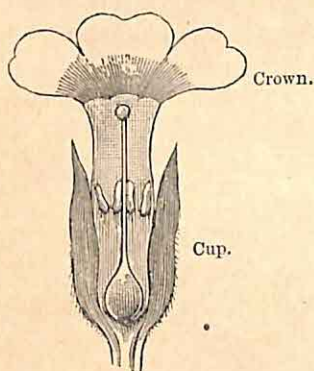


Fig. 55. Vertical section of a Primrose flower. The pistil has a long style, and the stamens are low down in the tube.

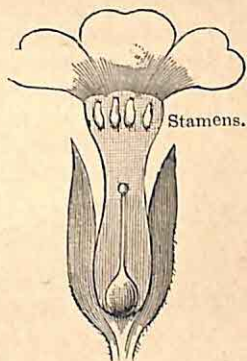


Fig. 56. Vertical section of another Primrose flower. The pistil has a short style, and the stamens are at the top of the tube.

## LESSON II.

### A WALLFLOWER.

"We saw the yellow wallflower wave  
Upon a mouldering castle wall."—*Miller.*

*Flowers on stems; one stem of flowers for each pupil. A branch of a well-grown plant.*

#### GENERAL OBSERVATIONS.

1. The wallflower is so called because it frequently grows on old walls, though it is now oftener seen in gardens. It is not one of our native wild flowers.

2. Observe:—

- (a) The flowers are variously and brightly coloured.
- (b) They grow in clusters at the tops of the stems or branches.
- (c) They are inserted on the stem by short stalks.
- (d) The stem is woody, and bears long narrow *sessile* leaves.

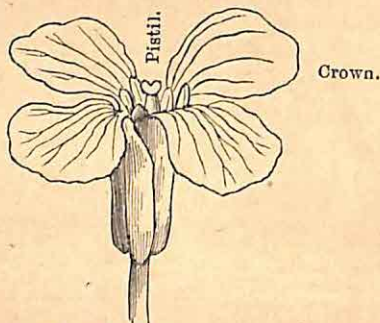


Fig. 57. Wallflower.

#### THE CUP AND THE CROWN.

1. We will proceed now to examine a single flower more closely. Take one off by its stalk. Look at the crown; notice its parts; they form a cross.

- (a) The crown of the flower is yellow (or other colour).
- (b) It is made of *four* leaves which form a *cross*.



2. Now let us look at the *cup*; press back one of the points with your needle. This part separates from the other part. Do the same with the others, and take them all off, laying them carefully down.

(a) The cup is small, and of a reddish-brown colour.

(b) It is made of *four* separate leaves.



Fig. 59. Cup of Wallflower, consisting of four leaves.

3. Press back the leaves of the crown; they are also separate; take them off one by one and lay them down. Observe:—

(a) The crown is composed of *four* separate leaves.

(b) The crown leaves have each a broad spreading part and a long narrow part.

(These are called the *LIMB* and the *CLAW*.)

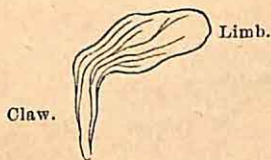


Fig. 59. Crown leaf of Wallflower.

## STAMENS AND PISTIL.

1. We now take the remaining portion of the flower. Observe:—

(a) The stamens have not come away with the crown.

(b) They remain attached by long stalks to the flower stalk.

(c) There are six stamens.

2. Now we will carefully remove the stamens one by one with the aid of the needle; we have the pistil left standing in the.

middle on the flower stalk. It is not quite of the same shape as that of the primrose. We shall examine the stamens and pistil more closely in the next lesson.

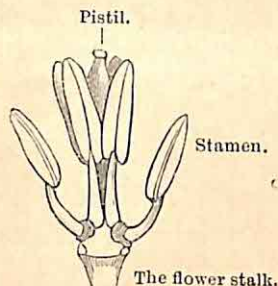


Fig. 60. Stamens and pistil of a flower of the Wallflower kind.

### PARTS OF A WALLFLOWER.

1. We have found that a wallflower consists of:—

- (a) A cup of *four* separate leaves.
- (b) A crown of *four* separate leaves.
- (c) Six stamens.
- (d) A pistil.

2. Comparing the cup and crown with those of the primrose, we find:—

- (a) In the wallflower both are made of separate leaves.
- (b) In the primrose each is in one piece, with points and notches.

*Note.* For this lesson in Summer, the best alternatives would be, stocks, radish, or candy-tuft.

### EXERCISE.

*Let all examine and compare as in the above two lessons, any of the suggested specimens obtainable.*

## LESSON III.

## STAMENS.

*Flowers of primrose and wallflower for every pupil.*

## STAMENS COMPARED.

1. In this lesson we will examine more closely those parts of the flower which we did not find until we had stripped away the outer parts—the stamens and pistil.

2. Remove the cup and crown of a wallflower so as to expose the stamens. Now let us look at the stamens of the primrose and compare the two sets:—

(a) In both cases the stamens have tops covered with yellow dust  
(This dust is called *pollen*.)

(b) The wallflower stamens have stalks, but those of the primrose are sessile.



Fig. 61. Stamen of Wallflower split open to discharge pollen.

## GENERAL CHARACTERS.

1. We may then conclude that stamens can do without stalks; but what is the dusty part that appears in both? Take a little pollen and rub it on your finger. It consists of small grains. A magnifying glass will show the shape of them.

2. There will no doubt be an unopened flower on many of the specimens. Let us take one, open it, and find the stamens:—



(a) Stamens in the bud are smooth, and of a pale yellow colour at the top.

(b) The head of each has a furrow down the middle

(c) When cut, the pollen is found inside.

3. As a matter of fact, in the opened flower the head of each stamen has burst to let out the pollen ; in the bud the stamens are not ready for opening. What the use of this pollen is we shall see in another lesson ; at present see :—

(a) The head is the more important part of the stamens.

(b) Pollen is produced in the heads of the stamens.

The pistil we will examine more closely in the next lesson.

#### EXERCISE.

*Take any of the specimens suggested, and let each pupil make a careful examination of the points already brought out.*

### LESSON IV.

## THE PISTIL.

*Specimens as in last lesson or similar. Some old flowers with petals falling away.*

#### OUTWARD APPEARANCE.

1. We will again look at a primrose pistil, and compare it with that of a wallflower :—

(a) In the primrose pistil there are distinctly three parts.

(b) The wallflower pistil shows only two parts

2. Now let us look at some old and falling flowers. Take a wallflower ; we find such lower down the stem. Observe :—

(a) In the old flowers, cup, crown, and stamens are falling away as if dead.

(b) The pistil remains and has grown larger.

(c) In other cases, only the pistil remains, and it has grown larger still—more than an inch in length.



Fig. 62. Flowering branch of Wallflower bearing flowers, flower buds, and fruit.

3. Make a similar observation of an old primrose flower. The pistil is found remaining :—

- (a) In a primrose the pistil continues as a little round ball.
- (b) The *cup* also remains round it.

4. It will be remembered that the part which remains after the flower has passed away is called the *fruit*. So then we may say :—

- (a) The pistil is the only part of the flower which in both cases continues to grow.
- (b) The pistil becomes the *fruit*.

## DISSECTION OF THE PISTIL.

1. Let us take out a primrose pistil. Fig. 63 represents that of a tulip. Now each must cut his specimen in two through the thickest part, either vertically or transversly. What do we find? Seeds. No, for if we were to sow these little soft bodies they would not grow. They would not be seeds until the pistil became fruit. Then they would be hard, brown, and larger.

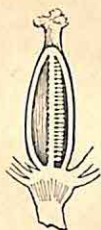


Fig. 63. Pistil of a Tulip cut vertically to show the ovules contained within it.

2. We will take a wallflower pistil. This can be opened by stripping up from the little notch at the bottom. The little bodies are clearly seen.

3. Examine the thin part of the primrose pistil. Observe:—

- (a) The thick part of the pistil contains small white bodies.
- (b) Each is fastened by a little stalk.

### PARTS OF THE PISTIL.

1. Now we must have a name for these little bodies; so we call them by one which means *little eggs*, that is, *ovules*, and the thick part in which they grow is called the *ovary*.

2. Of the other parts of the pistil we shall speak in another lesson. We now conclude:—

- (a) The thick part of a pistil is called the ovary.
- (b) The ovary contains ovules.
- (c) Ovules in time may become seeds.

### EXERCISE.

As a subsequent lesson take any of the following flowers, and let each examine his specimen, observing carefully the points already brought out:—ladies' smock, white rocket, campion, pink, elder flower, or honeysuckle.



## LESSON V.

## FLOWERS OF THE OAK.

*Catkins and pistillate flowers of the oak, with a branch showing the budding leaves (in April or May), or the same of the hazel (in March, of the poplar (in May), of the willow palms (in March or April), or those of the black bryony, a twining plant with dark shiny leaves growing in l'edges (June). Failing these, the lesson may be based on the flowers of the common stinging nettle (July), or those of the cucumber or vegetable marrow.*

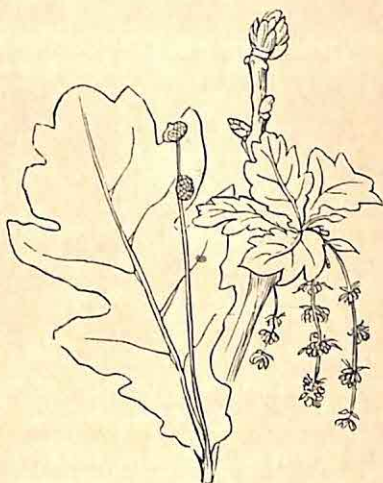


Fig. 64. Catkins (staminate flowers) and pistillate flowers of Oak.

## FLOWERING OF THE OAK.

Very few people notice the flowering of our large forest trees such as the oak; but everybody knows that the oak tree bears acorns, and that these are its fruit. If we walk under an oak tree just when the leaves are budding forth, especially after a strong wind or heavy rain, we may find the ground strewn with little tassels of a yellowish colour. Similar things are found on

the hazel a little earlier. These are called catkins. The so-called "palms" of the willow, both yellow and silver palms, are also catkins. Catkins also grow on the birch and poplar.

### CATKINS.

1. We will examine some of these catkins. Let us see what it is that makes the "fringe" of the catkin. With a knife remove one of the little scales. To each is attached a number of small bodies. They are like stamens.

2. Take off more scales. We shall see that the small bodies are stamens, some being covered with pollen.

3. Let us look what more these catkins bear—nothing. We thus conclude:—

(a) Each catkin is a thin stalk bearing a large number of scales.

(b) Within each scale are from six to twelve stamens.

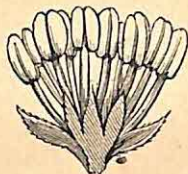


Fig 65. One of the staminate flowers of an Oak catkin.

4. Now we have found stamens in flowers. But our flowers have contained much more than stamens, a cup, a crown, and a pistil. Here we have none of these. Yet these are such flowers as the oak bears; and as they contain stamens without pistil, they are called *staminate* flowers. The catkins of the hazel, poplar, and birch are similar.

### PISTILLATE FLOWERS.

1. In the flowers we have hitherto observed, what was the fruit-producing part? The pistil. And what were to become seeds? Ovules. Now we know the oak produces acorns. These cannot grow from the catkins, for if you watch an oak tree you will find it soon loses all its catkins. Yet after a while acorns will be found growing on the tree.

2. Now if at the time the catkins are on the tree, we examine

the ends of the branches near the catkins we find little hard lumps partly surrounded by leaves just opening from the buds.

(Some specimens should be here to hand.)

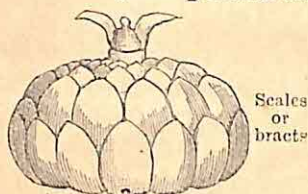


Fig. 66. Single pistillate flower of Oak.

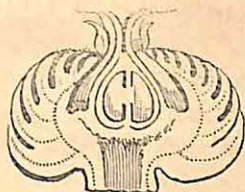


Fig. 67. Vertical section of a pistillate flower of Oak, showing two ovules.

3. Cut through your specimen, and by the aid of a glass you find :—

- (a) A number of surrounding scales.
- (b) In the middle three cells, each containing two ovules.
- (c) At the top three curved points.

4. This body, which contains the ovules, is a pistil ; it is surrounded by scales ; these scales become the cup of the acorn, which grows from being the pistil, and only one ovule ripens. We thus find :—

- (a) The oak has pistillate flowers.
- (b) From the pistillate flowers the acorns grow.
- (c) It also produces staminate flowers which drop off.

5. What may be the use of the staminate flowers and the stamens in other flowers we must leave for another lesson.

*Note.* The pistillate flowers of the hazel (Fig. 68) appear before the leaves, generally at the ends of the branches on which the catkins grow. They may be recognised as little tufts of red hairs (tops of the pistils) appearing just when the pollen is falling from the stamens of the catkins. The yellow "palms" of the willow are upright (not hanging) catkins of staminate flowers, and the "silver palms" are similar catkins of pistillate flowers. They grow on separate trees, never on the same.

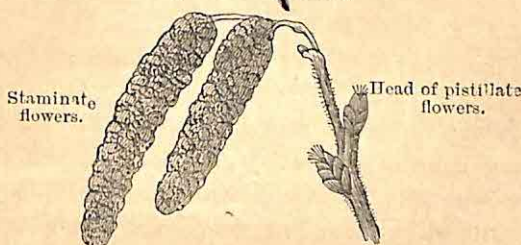


Fig. 68. Catkins of staminate flowers and heads of pistillate flowers of Hazel.



## LESSON VI.

## POLLEN AND OVULES.

*Flowers (to show stamens and pistil) of primrose or lily, and wallflower; if possible, a staminate and a pistillate flower of cucumber or vegetable marrow.*

## REVIEW.

1. Let us now consider what *parts* we have found in the flowers we have hitherto examined:—

- (a) Some were made up of *cup, crown, stamens, pistil*.
- (b) Some contained stamens *only*, others a *pistil only*.
- (c) In all cases there were either stamens or pistil, or *both*.
- (d) The pistil becomes fruit; but we did not find any purpose for which the stamens grew.

2. This we are now going to try to discover, but first we will examine a few pistils a little more carefully.

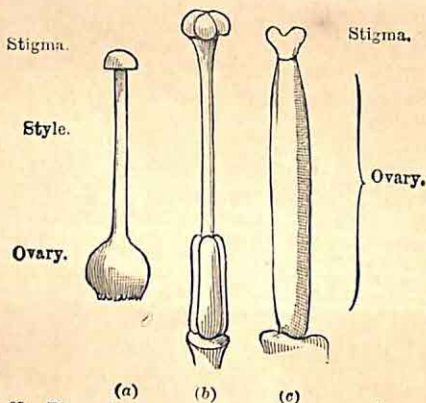


Fig. 69. Three pistils (a) primrose, (b) lily, (c) wallflower.  
In (c) the stigma is sessile on the ovary.

## PARTS OF A PISTIL.

1. Take the pistil of a primrose or a lily. One part we already know contains ovules and is called the ovary. Besides this there are:—

- (a) A long thin stalk above the ovary.
  - (b) A knob at the top of the stalk.
2. This stalk is called a *style*, and the knob at the top a *stigma*.
3. Look at a wallflower pistil; slit it open:—
- (a) There is a long narrow ovary.
  - (b) At the top of this is a knob or stigma.
  - (c) There is no style
4. If we examine other pistils we shall always find two parts present, sometimes three, *i.e.*, *ovary* and *stigma*, sometimes a *style*.

### A STAMEN.

1. We have already noticed the two parts of a stamen of a wallflower:—

- (a) The stalk.
- (b) The head.

This head is called an *anther*.

2. We also noticed:—

- (a) Pollen is produced in the anthers.
- (b) Sometimes, as in the primrose, stamens consist of anthers only.

### ESSENTIALS.

1. We may then draw certain conclusions as to what parts of pistils and stamens (of the flowers we have seen) appear to be necessary from the fact that those parts are always present:—

- (a) Every pistil (seen) has an ovary containing *ovules*, and a *stigma*.
- (b) Every stamen (seen) has an *anther* producing *pollen*.

### STAMENS AND PISTIL.

1. Carefully examine the stigmas of pistils on first opening out a flower. Small grains of pollen are often to be seen adhering to them. This is even the case where the pistils grow in flowers having no stamens.

2. To go a step further, observe two cucumber flowers—one is staminate, the other pistillate. Now cucumbers are grown under

glass. The cucumber which is eaten is produced from a pistillate flower; nothing grows from the staminate flower. But if the gardener were to carefully cut off all the staminate flowers of his plants and throw them away as soon as they opened, he would find that either no cucumbers would grow from the pistillate flowers, or if they did, the seeds in them would be useless. Or suppose instead he carefully covered all the pistillate flowers with glass shades; the result would be the same. Now a gardener does nothing of the kind. He lets the flowers grow freely, and by some means or other pollen finds its way to the stigmas of the pistillate flowers. To be quite sure of this, a gardener will sometimes take it himself, and place it on the stigmas.

3. There are then two things we want to know something about:—

(a) How does the pollen get on to the stigmas?

(b) Why is it necessary for the pollen to be taken to the stigmas?

4. The first question is easily answered, if you think a little. What are always visiting flowers? Bees. That is so. Bees and various insects, such as butterflies, moths, and beetles visit flowers to get out the honey or nectar, and in doing so, carry pollen from one flower to another. As they dive into a flower the pollen is brushed from their heads and shoulders, on to the stigma, which generally stands up prominently at the entrance to the flower. Look at a primrose or a wallflower.

5. The second question cannot be fully answered at present, but we may say this, that the pollen grains after falling on the stigmas begin to grow down the pistil, and continue to do so until they meet with the ovules. Immediately a change takes place in the ovules; and they begin to grow into seeds. Perhaps you remember that a seed contains a *little plant*. When a pollen grain enters an ovule this little plant begins to form; without the pollen grain, no little plant would be formed. The exact process we shall consider at a later stage. It is called the fertilization of the ovule, *i.e.*, the ovule then becomes fertile, or capable of becoming a seed.



## SUMMARY.

We may summarize:—

- (a) From flowers *seeds* are produced.
- (b) Seeds grow from ovules fertilized by pollen grains.
- (c) *Ovules* and *pollen* are therefore produced for the formation of seeds.
- (d) The pistil producing ovules and the stamens producing pollen appear to be the most important parts of a flower.

In the following lessons we shall examine how far this is the case in other flowers, and what kind of organs are set apart for the performance of this work.

## LESSON VII.

## CALYX AND COROLLA.

*Specimen of such flowers as wallflowers and primroses; some flower-buds.*

## THE OUTER WHORLS OF THE FLOWER.

1. We have already found in such flowers as the wallflower, that there are two whorls or rings of leaves outside the stamens and pistil. We have called one the "cup" and the other the "crown."

2. Now these are not the names used by botanists. What we have called the "cup," is in some flowers quite unlike a cup as, for instance, in the buttercup or wild rose, but it is spoken of by a name which is made from a Greek word meaning *a cup*; it is called the *calyx*.

3. Similarly what we have called the "crown," is called the *corolla*, a word meaning *a little crown*.

4. A flower may then consist of:—

- |             |                              |
|-------------|------------------------------|
| (a) Pistil  | } Inner and essential parts. |
| (b) Stamens |                              |
| (c) Corolla | } Outer parts.               |
| (d) Calyx   |                              |

5. Of the outer parts we may say :—

- (a) The *calyx* is the outermost whorl of the flower.
- (b) The *corolla* is the whorl that grows between the calyx and the stamens. (*These two statements are important.*)

### PARTS.

1. The corolla of a wallflower is made up of four separate leaves, as we have already seen. These leaves are called *petals*. When a rose falls, those coloured leaves are the petals.

2. A calyx is often made up, in the same way, of separate leaves. These are called *sepals*.

3. Let all look at their primrose flowers, and observe :—

- (a) Neither calyx nor corolla are composed of separate leaves.
- (b) But each is divided into lobes by notches.
- (c) The number of lobes is five in each case, as also the number of stamens is five.

4. We therefore conclude that we have in this instance five sepals and five petals grown together; consequently :—

- (a) A corolla consists of petals which may be *separate* or grown together (*united*).
- (b) A calyx consists of sepals which may be *separate* or *united*.

### FUNCTIONS.

1. Let each examine some flower buds and observe :—

- (a) The calyx encloses the other organs of the flower.
- (b) It therefore serves as a protection to those organs until they are ready to be exposed.

2. If we watch bees and butterflies visiting flowers, we find that they always go to the brightly-coloured ones. We never see them seeking honey from oak, willow, or hazel flowers. It has been noticed that bees prefer blue flowers, but they will visit flowers of other colours if there are no blue ones near. What then is the conclusion? If the flowers were without colour, they would not be visited. If the flowers were not visited, the pollen would not be carried from one to another. Colour then leads the insect to the flower; in other words, it is an attraction. So we may say that the corolla is an attractive organ. It

is to an insect what a shopkeeper's sign is to an intending purchaser.

3. We then conclude :—

- (a) The calyx protects inner organs while they are forming.
- (b) The corolla attracts insects to come to the flower for honey.
- (c) In taking out the honey, the insect unknowingly carries away pollen, and just as unknowingly leaves it on the stigma of the pistil of another flower.
- (d) Thus *cross* fertilization (which produces better seeds) is secured.

### EXERCISES.

*Any flowers having calyx and corolla in sufficient quantity for each pupil to have at least one.*

Each pupil should now prepare tables or schedules like the one below, and fill them up for different flowers. This will be found the easiest and pleasantest way of familiarizing him with the characters of the various parts. Only the calyx and corolla are dealt with for the present. The last column requires an answer to the question—are the sepals (or petals) separate or joined together?

### FLOWER SCHEDULE.

| Organs. | Parts.          | No. | Separate or united. |
|---------|-----------------|-----|---------------------|
| Calyx   | * <i>Sepals</i> | 4   | <i>Separate</i>     |
| Corolla | <i>Petals</i>   | 4   | <i>Separate</i>     |

\* Filled up for a cabbage flower.

## LESSON VIII.

### BLUEBELL.

*This flower grows in great profusion in the woods in early spring, often covering the ground as with a blue carpet. If it is not available, any species of lily will do. Each pupil should have his own specimen, and there should be one entire plant.*



## GENERAL OBSERVATIONS.

Observe:—

- (a) The leaves are glabrous, parallel veined, and thick.
- (b) The stem is leafless, and is thickened into a scaly bulb just above the root.
- (c) When broken, a sticky liquid escapes.
- (d) The flowers are attached to the stem by short stalks, at the base of each of which there are two narrow coloured leaves (these are called bracts).
- (e) The flowers are blue, and hang mouth downwards, like bells (hence the name).

## THE FLOWER—THE OUTER PARTS.

1. Examine carefully and notice:—

- (a) There does not appear to be a double whorl of calyx and corolla.
- (b) There is apparently one whorl of blue leaves.

2. We must look at these a little more closely. How many are there? Notice the alternate ones. A large lily flower will show the arrangement more clearly:—

- (a) There are six blue leaves.
- (b) Three of these are inner and three outer.

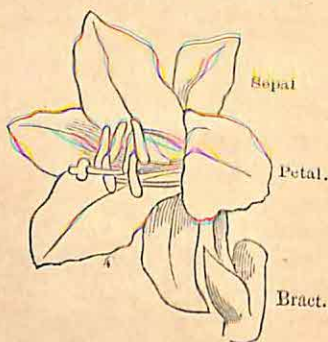


Fig. 70. Lily flower showing:—perianth of three inner and three outer leaves, six stamens and pistil.

3. The inner ones represent the corolla, and the three outer ones the calyx. When calyx and corolla grow thus, so that both together look at first sight like a calyx or like a corolla, it

is usual to call them a *perianth*. The word is also used sometimes when speaking of the calyx and corolla together. When a perianth is like a corolla, it is said to be *petaloid*; or when like a calyx, *sepaloid*. We thus see:—

- (a) The bluebell has a petaloid perianth.
- (b) This perianth consists of six leaves.
- (c) The three inner leaves are the corolla, and the three outer ones the calyx.

### THE FLOWER—THE INNER PARTS.

1. Take away the leaves of the perianth:—
  - (a) The perianth leaves are attached at the base.
  - (b) There are six stamens.
  - (c) Each stamen adheres to a perianth leaf.
2. The pistil now remains. The following points should be discovered:—
  - (a) The pistil consists of ovary, style, and stigma.
  - (b) The stigma is grooved, or divided into three parts.
3. Let us cut across the ovary, and look at the section:—
  - (a) In the ovary are three cells.
  - (b) In each cell are numerous ovules.
  - (c) The ovules are growing from the dividing walls or partitions.

#### SUMMARY:

- (a) The bluebell has a calyx of three sepals, and a corolla of three petals, the two forming a six-leaved perianth.
- (b) It has six stamens (two threes).
- (c) It has a pistil with a stigma divided into three parts, and a three-celled ovary.
- (d) So all the parts of the flower are in threes.

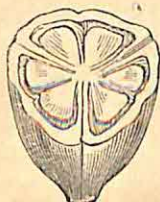


Fig. 71. Three celled ovary of a Tulip, seen in transverse section.

## LESSON IX.

## BUTTERCUPS &amp; LESSER CELANDINE.

"We saw upon the shady bank  
Long rows of golden flowers shine,  
And first mistook for buttercups,  
The star-shaped yellow celandine."

Miller.

*The celandine grows in the shade, and flowers earlier than the buttercup. It has entire, dark-green, shiny leaves, and its petals are narrow and pointed. Buttercups grow in open places, have usually divided leaves, and broadly obovate petals.*

*One whole plant of each should be provided, and every pupil should have one flower of each kind.*

*(N.B. The celandine may well be made the subject of a separate lesson, which, if the time be too early for buttercups, may be substituted for this.)*

## BUTTERCUPS.

1. This name is given to several different kinds of plants (all known by the name *Ranunculus*) having yellow cup-shaped flowers. Generally the stems are erect, but one kind has runners like the strawberry.

2. Let us notice a few prominent characters:—

(a) The stems and leaves are hairy.

(b) The leaves are much divided into lobes or leaflets.

3. It is on account of the shapes of the leaves, that some are known as Crowfoot. All are more or less poisonous.

(The Spearworts, which grow in wet ground, have narrow-lanceolate, and linear leaves.)

## THE FLOWER.

1. Let each now examine his flower in detail. Take first the outermost whorl, and detach the leaves one by one, laying them side by side on a paper or slate. The following should be observed and recorded:—



- (a) The calyx consists of *five* narrow, green (or brownish) sepals.
- (b) The corolla consists of *five* bright-yellow petals (occasionally six or even seven).
- (c) The petals are obovate and hollowed.
- (d) At the base of each petal is a small notch (this is called a *nectary*, the name given to that part of a flower which contains the honey or nectar).
- (e) The stamens are numerous (more than thirty), but of no definite number.
- (f) The centre of the flower consists of a number of small bodies.

2. Before examining this, notice where the stamens are attached—at the head of the flower stalk. The sepals and petals also grow from the same place.



Fig. 72. Pistil of Buttercup, composed of separate carpels. All stamens but two have been removed.

3. Now examine the centre of the flower. What might we expect to find here? The pistil. Take off one of the small bodies, and cut it open with a knife or needle. What is there within? A small white body, like an ovule.

4. This small body is an ovule, and each of the other green bodies contains one. We have then a cluster of pod-like bodies containing ovules. The whole is the pistil of the buttercup.

5. Look carefully at the tops of the green pod-like bodies. Seen through a magnifying glass, they present a rough or uneven surface. This is where the pollen grains fall—the stigmas of the pistil.

#### SUMMARY.

A buttercup flower consists of:—

- (a) Calyx of five *separate* sepals.
- (b) Corolla of five *separate* petals.
- (c) Numerous stamens growing below the pistil.
- (d) Pistil of numerous *separate* bodies, each having a stigma, but no style, and containing one ovule.

LESSON IX. (*continued*).

## THE LESSER CELANDINE

(OR FIGWORT *RANUNCULUS*).

1. The name celandine means *swallow-flower*. It is so called because the plant flowers about the time the swallow first appears.

"Ere a leaf is on the bush,—  
In the time before the thrush  
Has a thought about her nest,  
Thou wilt come without a call,  
Spreading out thy glossy breast,  
Like a careless Prodigal;  
Telling tales about the Sun,  
When we've little warmth or none."

*Wordsworth.*

2. Examine the plant and flower in the same way as the buttercup, recording all the characters. The following *differences* should be noticed:—

- (a) The roots are tuberous.
- (b) The leaves are kidney or heart-shaped glabrous, and entire.
- (c) The calyx is made up of three sepals.
- (d) The corolla of seven, eight, or nine petals, linear and pointed.
- (e) The corolla is not cup-shaped, but star-like.

## EXERCISE.

Schedule the results as below:—

## FLOWER SCHEDULE.

| Organ.  | Parts.                              | No. | Separate or united. | Where inserted.        | Remarks, shape, colour, &c. |
|---------|-------------------------------------|-----|---------------------|------------------------|-----------------------------|
| Calyx   | <i>Sepals</i>                       | 3   | <i>Separate</i>     | <i>Below the ovary</i> | <i>Linear, green</i>        |
| Corolla | <i>Petals</i>                       | 8   | <i>S-separate</i>   | "                      | <i>Linear, yellow</i>       |
| Stamens | <i>Anthems</i><br><i>and stalks</i> | ∞   | <i>Separate</i>     | "                      | —                           |
| Pistil  | Small<br>bodies.                    | ∞   | <i>Separate</i>     | —                      | <i>One ovule in each</i>    |

∞ is the symbol employed for "*numerous and indefinite*."

## LESSON X.

## MARSH MARIGOLD &amp; COLUMBINE

"Oh, winking marsh marybuds, rich and yellow!  
Give me your money to hold."

\* \* \* \* \*

"Oh, columbine! open your purple flower,  
Where two twin turtle-doves dwell."

Jean Ingelow.

*The marsh marigold is like a gigantic buttercup; it grows in marshy land; its leaves are large, glabrous, and undivided. The columbine is cultivated in old gardens. Every pupil should have a specimen of the flowers of each, and an entire plant should be present. If the flowers are obtained from a garden, care should be taken that they are single, not double.*

## MARSH MARIGOLD.

## 1. Observations to be led out:—

- (a) The plant grows on marshy land.
- (b) It has large kidney-shaped, glabrous leaves, with crenate margins.
- (c) The flowers look like large buttercups.

## 2. Examination, as in the case of the buttercup:—

- (a) There is only one whorl, which looks like a petaloid perianth.
- (b) The stamens are numerous.
- (c) The pistil consists of separate parts.

3. Closer examination of the perianth shows us no outer and inner leaves, such as we saw in the bluebell. We conclude, therefore (and for other reasons which cannot be entered into here), that we have not in this case a calyx and a corolla, but only one of those organs, and the question is, which? Now how did we define a calyx and a corolla in a previous lesson? The calyx is the outermost whorl of the flower. And we said, too, that the calyx was a protective organ. Now this perianth is:—



- (a) A protective organ,
- (b) The outermost whorl of the flower,
- (c) Green until it opens, and
- (d) It shows no trace of being made up of two whorls.

We therefore call it a calyx—a petaloid calyx, of (usually) five sepals.

4. Cut open one of the parts of the pistil. Unlike those of the buttercup, each contains several ovules.

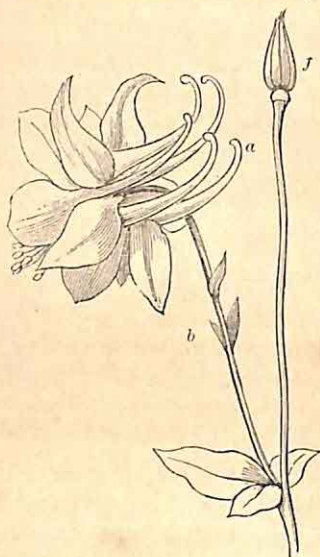


Fig. 73. Flower and fruit of Columbine.  
a Spurred petals. b Bracts. f Fruit.

## COLUMBINE.

1. Hold the flowers mouth downwards. All the leaves are coloured, and some have a backward projection, called a spur. Notice that the spurred ones alternate with smaller narrow ones; that there are five of each.

2. Now notice that each spurred leaf, with the two narrow ones, one on each side, bears a resemblance to a bird with its wings spread and tail expanded. From this fancied likeness to doves, the flower gets its name; for *columbine* is made from a Latin word, which means a *dove*.

3. Observe now the five spurred and the five narrow leaves; then remove them one by one:—

- (a) The narrow leaves form a ring outside the spurred leaves.
- (b) The spurred leaves are within, but their spurs project backwards, between the others.
- (c) The outer whorl is the calyx, and the inner the corolla.

4. The spurs of the petals are nectaries, just as those were at the base of the buttercup petals.

5. Now let us continue the examination of the flower:—

- (a) The stamens are numerous, and grow below the ovary as in the buttercup.
- (b) The pistil is surrounded by thin scales.
- (c) The pistil is made up of separate bodies, each containing several ovules, like that of the marsh marigold.

### SUMMARY.

1. Make schedules of both flowers as given in Lesson IX.

2. Compare with buttercup. Points of difference:—

- (a) The marsh marigold has no corolla.
- (b) The parts of its pistil (like the columbine) contain several ovules each, while those of the buttercup only one.
- (c) Its leaves are not divided.
- (d) The columbine has both sepals and petals coloured, and the latter are spurred.

3. Points of resemblance:—

- (a) All have pistils made up of separate parts, without styles.
- (b) All have numerous stamens.
- (c) All have calyx or corolla (or both when present) usually in fives.
- (d) The sepals and petals (when present) are separate.

*N.B.* This lesson may well be taken as two; but it has not been divided because it might not be possible to obtain both flowers, and one must then stand as the subject of the lesson, although it is desirable that both should be taken.

The greater celandine, a larger plant than lesser celandine, with an orange-coloured latex or milk in its stem, is a relative of the poppy, and has very small yellow flowers.

## LESSON XI.

### CARPELS.

*Any of the preceding flowers, especially columbine or marsh marigold, and lily or wallflower; some pea-pods; some leaves.*

#### FORMS OF PISTILS.

1. Of the pistils hitherto examined, we have notably two forms:—

(a) Those in one piece; *e.g.*, that of the *lily*, *oak*, or *wallflower*.

(b) Those in several separate pieces; *e.g.*, *buttercup*, *columbine*.

2. With regard to the former we noticed:—

(a) The stigma is usually divided into parts, and

(b) The ovary contains as many cells as the stigma divisions; *e.g.*, *wallflower*, two; *lily*, three.

3. The conclusion we arrive at then, is, that in such a pistil as that of the *lily*, there are *three* parts, but that they are joined or grown together; in the *columbine* they are not joined together.

4. We have already observed that the pistil ripens into the fruit, and it will easily be perceived that when the pistil consists of separate parts, these parts will appear separate in the fruit. Such a case is seen in the *blackberry*. From a Greek word meaning *fruit*, we get the word *carpel*, a *little fruit*, and this is

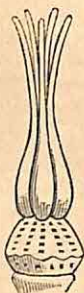


Fig. 74. Pistil of Columbine, composed of five separate carpels (apocarpous) enlarged.

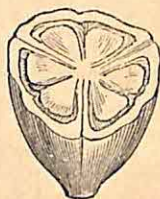


Fig. 75. Lower portion of ovary of pistil of a Tulip showing three cells (syncarpous).



the term applied to the parts of the pistil, whether separate or joined.

### WHAT CARPELS ARE.

1. It has previously been noticed that if we break off a piece of stem of certain plants, and lay it in the ground, it soon grows, and produces another plant. Now a seed is only a piece of a plant given off by the plant for the same purpose, and while it is being made ready to leave the parent plant, it is contained and nourished within a carpel. One carpel may be the whole pistil, as in the case of the pea; or the pistil, as we have seen, may be made up of several carpels either separate or united.

2. Take any leaf, preferably a lanceolate one, and fold it down the midrib so that the edges come together, and you produce something not unlike a pea-pod, or a single carpel of the columbine. Take off the separate carpels of the columbine and compare.

3. We thus see what a carpel is like, and what it really is—a leaf folded and specially modified for the purpose of being a vessel to contain the seed while it is being formed.

4. In the same way, stamens are little folded leaves, modified so as to contain the pollen. The folding though, is somewhat different. The edges are rolled inwards on to the midrib, so as to produce two lobes in the anther. This will be referred to in a future lesson.

### TWO KINDS OF OVARIES.

1. We see then, that where the carpels are united, this union exists essentially in the lower part, that is, the ovary; for very often the stigmas remain separate, and sometimes the styles also. In describing pistils, we speak of the ovary as consisting of either separate or joined carpels, or we use words which mean the same.

2. These words are made from the Greek word above referred to, with the addition of a prefix. *Syn* means together, and *apo*,

apart. So we get *syncarpous* and *apocarpous*, and these are the terms applied to ovaries.

3. Let us then classify the flowers we have examined under these two heads:—

(a) Those with syncarpous ovaries—

Lily, wallflower, primrose, oak, cucumber, black bryony, tulip, hyacinth.

(b) Those with apocarpous ovaries—

Buttercup, marsh marigold, lesser celandine, columbine.

### EXERCISE.

*Let each pupil fill up a schedule as below, for some one of the above flowers. There should be as many different kinds as possible, and the more exercises taken the better.*

### SCHEDULES.

(a) PISTIL OF LILY.

|                |                                 |
|----------------|---------------------------------|
| Ovary          | <i>Syncarpous, three-celled</i> |
| Style          | <i>One</i>                      |
| Stigma         | <i>In three parts</i>           |
| Ovules         | <i>Several in each cell</i>     |
| No. of carpels | <i>Three</i>                    |

(b) PISTIL OF BUTTERCUP.

|                |                           |
|----------------|---------------------------|
| Ovary          | <i>Apocarpous</i>         |
| Style          | <i>None</i>               |
| Stigmas        | <i>As many as carpels</i> |
| Ovules         | <i>One in each carpel</i> |
| No. of carpels | <i>Numerous</i>           |

LESSON XII.

CUCKOO FLOWER.

(LADIES' SMOCK.)

"Lady smocks all silver white."

*Shakespeare.*

*One whole plant and flowers sufficient for each pupil, or the same of any of the following:—cabbage, charlock (a wild mustard growing as a weed on cultivated land), garden stock, radish, or wallflowers.*

*Found almost everywhere in meadows in May, and recognised by its pretty pale lilac flowers.*

HABITS AND GENERAL CHARACTERS.

1. The plant is said to derive one of its names from the fact that it flowers at the time of the coming of the cuckoo; its other, from the appearance it gives to the fields, for when in full flower, it often covers the ground with such masses of white as to look like linen bleaching. Seen closer, the flower is of a pale pinkish purple or lilac colour. It is one of our prettiest spring flowers.

2. Let us examine our plant more closely:—

- (a) The stem is erect, and about nine inches to a foot in height.
- (b) The leaves are compound, pinnate.
- (c) Leaflets of radical leaves, round or ovate; those of the cauline leaves, linear.
- (d) The root or stem when bruised, smells like cress. (It is also called Meadow Bittercress.)
- (e) The flowers are borne on short stalks at the top of the stem.

THE FLOWER.

1. Proceed to examine as before, observing and recording:—

- (a) Calyx—four separate sepals, two slightly lower than the others.
- (b) Corolla—four separate petals forming a cross. (Such a corolla is said to be *cruciform*.)
- (c) Stamens—six (four long, two short) inserted below the ovary.



2. Notice why two stamens are shorter. There is a little green lump on the inner side of each; these are nectaries, and they cause the base of the stalks to grow out further (see fig. 60).

3. The pistil now remains; cut across; open up from base:—

(a) The pistil consists of a long ovary and stigma like a knob; there is no style.

(b) The ovary is two-celled, and contains several ovules.

(c) It is syncarpous, and made up of two carpels.

4. Notice the numbers of the parts:—

Calyx 4, or 2 twos.

Corolla 4, or 2 twos.

Stamens 6, or 2 twos + two.

Carpels 2, or 1 two.

It will easily be recalled, that a previous flower had exactly the same numbers arranged in the same way. If not, examine the wallflower again.

### EXERCISE.

A complete form of schedule is now given, which can be used throughout the remainder of the course. It is filled up for the Cuckoo Flower as an example, and a list of flowers is appended for exercise. **COHESION** being a term used to imply the union of like parts, it is here used of the like parts of the flower; thus when we speak of the cohesion of the sepals, etc., we mean, are they *separate* or *united*?

### QUESTIONS.

1. What are the essential parts or organs of a flower?
2. Name any flowers you know that have none but the essential organs?
3. What is the purpose of a flower?

FLOWER SCHEDULE.

| Organ.  | Parts.             | No.                  | Cohesion.  | Where inserted.                           | Remarks—<br>Shape, colour, etc. |
|---------|--------------------|----------------------|------------|-------------------------------------------|---------------------------------|
| Calyx   | Sepals             | 4                    | Separate   | Below the ovary                           | Small, linear                   |
| Corolla | Petals             | 4                    | "          | "                                         | Lilac, spreading, obovate       |
| Stamens | Anthers and stalks | 4+2                  | "          | "                                         | 4 long, 2 short                 |
| Pistil  | Carpels            | 2                    | Syncarpous | Flower stalk                              |                                 |
|         | Ovary cells        | 2                    |            |                                           |                                 |
|         | Styles             | None                 |            | Name—Cuckoo Flower.<br>Date—<br>Locality— |                                 |
|         | Stigmas            | 1                    |            |                                           |                                 |
|         | Ovules             | Several in each cell |            |                                           |                                 |

N.B. In working the Exercises, the terms in the first column and those at the heads of the other columns are given to the pupil, and he is required to fill up the remainder from the examination of the specimen laid before him.

*Flowers for exercise.* Those given at the head of Lesson XII., together with mustard, cress, arabis (a rock plant cultivated, flowers white), turnip, candytuft, alyssum, shepherd's purse (a common weed in gardens and by road sides under walls, flowers small, fruit like little inverted purses).

Most of these plants are wholesome, none are poisonous.

## LESSON XIII.

## A POPPY.

*Specimens as suggested in previous lessons of wild or garden poppies; if none are to hand, the yellow eschscholtzia, commonly cultivated, will serve as a substitute.*

## HABIT AND CHARACTER OF PLANT.

1. The common wild poppy is generally well known by the scarlet colour of its flowers. It is most frequently found amongst the corn, or on protected banks.

2. Examine the plant:—

- (a) The stem is herbaceous, hairy, erect, from one to two feet high.
- (b) When broken, it gives off a white milky juice.

The milky juice collected from one species of poppy and dried is *opium*. *Laudanum* and *morphia* are also made from it. Its special property is that of producing sleep.

- (c) The leaves are twice divided, but not to the midrib; they are pinnatifid.
- (d) The flowers are borne on long slender stalks.

## THE FLOWER—CALYX AND COROLLA.

1. Examine the flower, and *fill up a schedule* as shown in the last exercise. At first sight there appears to be no distinction between calyx and corolla—only one whorl of scarlet petals. But let us look at some buds; if one is just opening it will suit our purpose better. Then we shall see that as the bud opens, the calyx is pushed off, the sepals are loosened at the base and fall to the ground.

2. We notice, too, that the petals are crumpled in the bud, and if we gather the plant they very soon fall away too. We can therefore record:—

- (a) Calyx—two sepals, separate falling on opening.
- (b) Corolla—four petals, separate, broad, thin, scarlet.



## STAMENS AND PISTIL.

## 1. Having removed the petals we see :—

- (a) The stamens have black anthers.
- (b) They are numerous, separate, and inserted below the ovary.

## 2 The pistil now remains :—

- (a) It is large and globular, and the top is nearly flat.
- (b) It has no style.
- (c) The stigmas take the form of several lines or rays on the flat top.

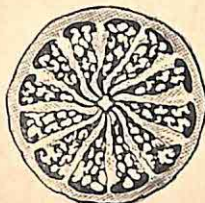


Fig. 76. Transverse section of the ovary of a Poppy, showing twelve imperfect cells, for the partitions do not reach the centre.

## 3. Cut the ovary transversely :—

- (a) It is divided into cells, as many as there are stigmas, and the ovules grow on the partitions.
- (b) The division is not quite complete, for the partitions do not reach the centre.
- (c) We conclude that it is made up of *several carpels*, generally from eight to twelve.
- (d) The ovary is syncarpous ; ovules very numerous in each cell.

## SUMMARY.

- (a) Calyx—two sepals (sep.).
- (b) Corolla—four petals (sep.).
- (c) Stamens— $\infty$  (sep.).
- (d) Pistil—twelve carpels ; ovary, syncarpous.

## LESSON XIV.

## PANSIES AND VIOLETS.

"The Violet by the mossed grey stone."

Elliott.

*Specimens of any violets, and a good supply of garden pansies sufficient to give every pupil two flowers; a complete plant.*

## HABIT AND GENERAL CHARACTERS.

1. Both violets and pansies are readily recognised by their peculiarly-shaped corollas, and the way in which the face, as it appears to be, is turned downwards.

2. Violets flower in spring, and should be looked for in shady nooks and undisturbed spots under hedges. The flowers are of one colour (purple), and the leaves cordate and stipulate.

3. As the pansy is a much larger flower, and the parts are more easily seen, we will take it as a representative; the violet can be examined afterwards.

4. Of the plant as a whole, observe:—

(a) The stem is slender and ascending.

(b) The leaves are remarkable for their large stipules.

(c) The flowers are borne singly on long stalks, and the face is turned downwards, owing to a bend in the stalk.

(d) The flower stalk has two very minute bracts half-an-inch or more below the flower.

## THE FLOWER AS A WHOLE.

1. As this flower is not quite so simple as the preceding one, it will be necessary to examine it with more care. We will take it as a whole, then in section, and finally in detail. This will be the general plan in future.

2. First then, without dissection, the following points may be observed:—

(a) The calyx—five oblong sepals, each having a broad lobe projecting backwards.

(b) The corolla—five large spreading variously-coloured petals.

(c) The petals are of different sizes and shapes.

Such a corolla is said to be *irregular*, those of the buttercup, columbine, wallflower, etc., are *regular*.

3. Hold the flower in its natural position; observe:—

- (a) There are two back petals, two side petals, and one in front which is the largest.
- (b) The mouth or throat of the flower is fringed with tufts of hairs that grow on the petals.
- (c) The colours round this throat vary from the other parts of the petals, or the entrance is marked by lines. (These are thought to be honey guides for the bees.)
- (d) The stigma of the pistil fills the throat, and is seen as a round knob.

4. Look at the back of the lower or front petal:—

- (a) It has a spur which passes backwards between the sepals.

*(It is suggested that the lesson be divided at this point.)*

#### LESSON XIV. (continued).

*Flowers and a prepared schedule form for each pupil.*

#### THE FLOWER IN SECTION.

1. Insert the point of a knife longitudinally in the stem at the back of the flower, and with a rapid movement pass it forwards, so as to cut the flower through the middle, dividing the ovary and spur.

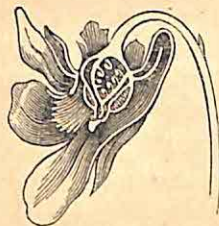


Fig. 77. Vertical section through middle of a Pansy flower.



## 2. Observe these sections :—

- (a) The stamens lie round the ovary and style, and very close
- (b) The stalks are very short, the anthers broad.
- (c) The two lower or front stamens have each a thin spur-like projection, which extends into the spur of the front petal.
- (d) The ovules are seen attached to the walls of the ovary.
- (e) There is a short bent style.
- (f) The knobbed stigma has a little hole in it.

3. A sectional view, such as we are now examining, shows clearly where the stamens, petals, and sepals are inserted. In this case all grow below the ovary on the flower stalk.

4. The honey or nectar of the flower is formed in the little spurs of the stamens, and stored in the spur of the large front petal. Look now at an uncut flower, and you will see what a bee must overcome to get to this storehouse of honey. The stigma blocks the way, but this can easily be lifted, owing to the bend in the style. His head passes underneath it, as he pushes his long trunk down into the spur. But in doing this, he comes in contact with the stamens that lie just beyond the stigma, and so he brings away some pollen as well as honey. Then he visits another flower, and as he lifts the stigma to get to the honey, as before, the pollen is brushed off the top of his head or trunk into the hole in the knobbed stigma. Thus the pollen is placed for the fertilization of the ovules. So wonderfully are the insect and the flower designed to satisfy each other's needs.

## THE FLOWER IN DETAIL.

1. Let each pupil now take another flower, and take it to pieces, as has been done in previous lessons, filling up his schedule as he does so.

2. Take off (1) the sepals, holding each by its two parts to do so neatly; remove (2) the petals, the spurred one last, so as not to injure the spur or the spurs within; remove (3) the stamens with the aid of knife, needle, or clean pen :—

- (a) Calyx—five sepals, separate, lobed backwards.
- (b) Corolla—five petals, separate, irregular, one spurred.
- (c) Stamens—five, almost united round the ovary, styles short, inserted below the ovary.

3. Cut the ovary across, *i.e.*, transversely, or in a direction at right-angles to the section previously made :—

- (a) Stigma, 1, knobbed and hollow.
- (b) Style, 1, bent.
- (c) Ovary, 1—celled.
- (d) Ovules,<sup>2</sup> many attached to the walls of the ovary, in *three* places.



Fig. 78. Ovary of Pansy seen in transverse section, to show the ovules attached to the walls.

From this fact we infer that the pistil is formed of three carpels joined together, and that the places where the ovules are attached are the points of juncture. If we take the illustration of the leaf previously suggested, and imagine three placed together, joined at their edges (and it is at the edges that the ovules are formed) we shall see how this form of ovary arises. *This is best seen by making a model in paper.*

We then conclude :—

- (a) The ovary of the pansy is syncarpous.
- (b) The whole pistil is made up of three carpels.

### QUESTIONS.

1. Describe the place where blue-bells grow.
2. What does the midrill of the blue-bell flower become? If you do not know, go to the place where they grow later in the summer.

## LESSON XV.

## A GARDEN PINK.

A supply of pinks or sweet williams, and schedule forms prepared (if not printed, pupils should prepare their own, while the specimens are being distributed).

In lieu of the above, any of the following may be used:—corn cockle (known by its long sepals, found amongst the corn); the red, white, or bladder champions (the last is known by its swollen calyx tubes, and the white champion or *lychnis*, by its fine rotate or wheel-shaped white or pale pink flowers, found in handsome groups in cornfields, in June or July; the red champion flowers earlier, preferring woods and shady places); the ragged robin (with much divided pink petals, found in marshy land); stitchwort (see Fig. 99), or chickweed.

## THE PINK.

## 1. Characters of the plant to be observed:—

- (a) The stem is herbaceous, and swollen at the nodes.
- (b) The leaves are linear, glabrous, and sessile.
- (c) The whole plant is whitish in colour.

2. Notice the bracts close up to the calyx of the flower—two, four, or six.

## THE FLOWER.

## 1. Cut the flowers longitudinally:—

- (a) The flower is *regular*.
- (b) It has calyx, corolla, stamens, and pistil (*complete*).
- (c) All the three outer whorls are inserted below the ovary.
- (d) The ovary is raised on a short stalk within the calyx.

## 2. Now let us take the flower in detail:—

- (a) Calyx—five sepals united.
- (b) Corolla—five petals separate, with long claws, toothed.
- (c) Stamens—ten separate, in two whorls of five.
- (d) Pistil—styles and stigmas two, ovary in one piece.



## 3. Cut the ovary transversely :—

- (a) The ovary is one-celled.
- (b) The ovules are attached to a central mass, as in the primrose.



Fig. 79. Ovary of Pink; cross section to show the ovules attached to the central mass.

As there is no division into cells, the two styles guide us to a conclusion that the pistil is made up of *two carpels*. We have therefore :—

- (a) A pistil of two carpels in the form of
- (b) A syncarpous ovary surmounted by two long styles.

## EXERCISE.

*Schedule any of the flowers named at the head of this lesson.*

*Note.* With regard to the red and white campions (*lychnis*), it should be observed that stamens and pistil are seldom found in the same flower. The staminate flowers having no pistil, and the pistillate flowers having a five-styled pistil, and little points or projections to represent the stamens. The bladder campion, which is a *silene*, has only three styles. Stitchwort and chickweed have small flowers with three styles.

## LESSON XVI.

## PLACENTATION.

*Pistils of (1) columbine; (2) poppy, pansy, or gooseberry; (3) lily, tulip, or hyacinth; (4) campion or pink.*

## A COMPARISON.

## 1. We have already seen that ovaries are either :—

- (a) Syncarpous, or
- (b) Apocarpous.

But it will be chiefly the former with which we shall be concerned in this lesson.

2. Take an ovary of each of the four groups mentioned at the head of this lesson, and cut transversely so as to show the position of the ovules, as we have seen them in the preceding lessons.



Fig. 80. Transverse section of ovary of Pansy, to show wall-placentation.

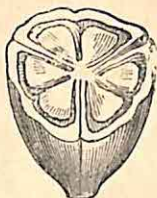


Fig. 81. Transverse section of ovary of a Tulip, showing axile placentation.

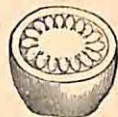


Fig. 82. Transverse section of ovary of Pink, to show central placentation.

3. Notice especially those of the tulip and pink :—

- (a) The ovules are attached to a mass in the centre.
- (b) In the pink, the mass is entirely central.
- (c) In the tulip, it forms divisions between the cells.
- (d) Even in the pansy there is a slight inward growth of the wall, to which the ovules are attached.

4. Now this mass or structure out of which the stalks of the ovules grow is known as a *placenta*, and as we have three forms in which it grows, we say we have three different forms of *placentation*.

#### FORMS OF PLACENTATION.

1. Comparing these three forms, we have first, the pansy, in which the ovules are inserted on the wall, so we call this a *walled* placentation.

2. In the case of the pink, it is obvious why the placentation is said to be *central*.

3. In the other case, that of the hyacinth or tulip, the placentas divide the cells and radiate from the axis, so the placentation is said to be *axile*.

4. Take now a single carpel of columbine, and open it down the inner side; the ovules are found only on the edge or margin; in such a case the placentation is said to be *marginal*.

## RELATION OF THESE FORMS.

1. Take three carpels of columbine ; place them together, and try to imagine what the placentation would be had they grown fast together ; it would be three-celled and axile as in the tulip.

2 Now open each one down the inner side (as we open a pea pod) and imagine them grown together in a whorl, but not united in the centre ; the six edges would be united into three, and would present the appearance seen in the pansy, poppy, or gooseberry (in which, however, there are but two carpels).

3. If we think of the axile placentation again, and imagine what it would be like if the connection with the walls were severed, we shall see a central placentation.

## SUMMARY:

Placentation may be :—

- (a) *Marginal* in the case of single carpels.
- (b) *Walled* in one-celled syncarpous ovaries.
- (c) *Axile* in two- (or more) celled syncarpous ovaries.
- (d) *Central* in one-celled syncarpous ovaries.

In filling up schedules, these points must be attended to, and the necessary term placed in the column for remarks. Thus :—*placentation, axile* ; or, as in the case of the pink, *placentation, central* ; or wallflower, *placentation, walled*.

(N.B. The division in the ovary of the wallflower is not due to the union of the carpels, but the growth of the axis, hence it remains when the carpels fall away. This is treated in dealing with fruit.)

## BRIEF NOTES

ON

## A FEW SUMMER FLOWERS.

It will probably be desirable to examine and schedule other flowers besides, or as substitutes for, those referred to in the foregoing lessons ; at least, the following notes may suggest an acquaintance with some of our most frequent summer flowers.



**Larkspur** (*delphinium*), an elegant garden plant, four to six feet high, bearing long spikes of usually bright blue flowers. It is the calyx which is coloured, the petals being very small. The calyx is also extended into a spur, hence the name.

**Monkshood** (*wolfshane* or *aconite*). This is also a tall cultivated plant, with palmately divided leaves (see Fig. 11). Its flowers are generally of a dark purple, and in this case also it is the sepals that are coloured, the upper one being in the form of a large hood or helmet, covering the inner parts of the flower. When this hood is removed, two strangely-shaped petals are seen, which act as nectaries. The plant is very poisonous. Its popular names, monkshood and wolfshane, are derived, the one from the form of the flowers, and the other from the fact that parts of the plant used to be mixed with meat for baiting wolf traps.

**Mallow.** All the mallows are herbaceous plants. The flowers are of a rose pink (in one species), or a pale purple. They are most easily recognised by the way in which the stamens form a tube round the styles, splitting at the top into a tuft of one-celled anthers. The large garden hollyhock resembles them closely, as does also the cotton plant. In fact, both these are said to belong to the mallow tribe or family. The mallows are wholesome, and are used as medicine, on account of the mucilage which can be boiled out of their stems and leaves.

**Flax.** The flowers of the red flax, so often grown in gardens, and the blue flowers of the flax from which linen is made, are exceedingly pretty. The latter may be grown by sowing linseed.

**St. John's Wort.** There are several species bearing this name. All have more or less dense handsome clusters of orange-yellow flowers, and may be recognised by the numerous stamens being arranged in three or five bundles, as well as by the small black dots which mark the anthers, petals, sepals, or leaves of several species. The tea plant of China is related to this family.

**Crane's-bill.** There are several of this name, all characterized by the pistil lengthening out, after flowering into a bill-like axis, from which the name is derived. The meadow crane's-bill has handsome purple flowers, but perhaps the Herb Robert will be most commonly met with. It has small flowers, red hairy stems, twice or thrice pinnate leaves, which also turn red in the autumn, and the whole plant when rubbed has a disagreeable smell. It flowers in early summer.

**Lime.** The sweet-scented flowers of the lime tree should be noticed. The flower stalk has a long bract, which gives the flower the appearance of growing out of a leaf. The cacao or cocoa plant is closely related to the lime.

## LESSON XVII.

### SILVERWEED.

*A pretty and very common road-side plant. It has running stems which root at the nodes; leaves pinnate, white with silky hairs underneath, often looking as if dusty from the white road; flowers yellow, not unlike buttercups, on simple stalks rising from the rooting nodes.*

*In lieu of this cinque foil, which has similar stems and flowers, but green palmate leaves; the herb bennet, strawberry or bramble flower. Plant and flowers as in previous lessons; schedule.*

#### THE PLANT.

Observe the following points :—

- (a) The stems creep and take root like those of the strawberry.
- (b) The leaves are pinnate, alternate pairs of leaflets being large and small, and all are white with silky hairs underneath.

#### THE FLOWER—NEW FEATURES.

1. It may be noticed that the flower bears a general resemblance to a buttercup, but it will soon be seen that this is only an apparent one.

2. Observe generally first :—

- (a) The calyx is double or consists of two whorls.
- (b) The corolla is yellow and cup-shaped.
- (c) The stamens are numerous.
- (d) The pistil has the appearance of that of the buttercup.

3. Look at the stamens to discover where they are inserted. Cut the flower in two vertically by passing the knife through the middle of the top of the stalk and upwards; remove one of the petals. Show on a larger scale in the strawberry flower :—

- (a) The stamens grow on the calyx.
- (b) They form a ring at their base *round the pistil (or ovary)*.
- (c) The petals grow in the same place.

4. This is a point of difference. In the buttercup, columbine, &c., we found the stamens *inserted below* the ovary on the flower stalk. Notice then the new features in this flower :—



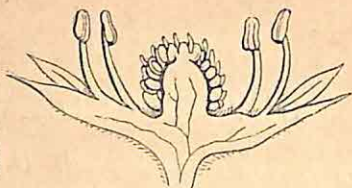


Fig. 83. Vertical section through centre of a Strawberry flower, showing the insertion of the stamens on the calyx; the petals have been removed.

- (a) The calyx double and sepals united. (Sepals were united in the pink.)  
 (b) Stamens and petals inserted on the calyx, round the ovary.

### THE FLOWER IN DETAIL.

#### 1. Make detailed examination for scheduling :—

- (a) Calyx—double, sepals 5 + 5, united.  
 (b) Corolla—petals five, separate, round the ovary.  
 (c) Stamens—numerous, separate, round the ovary.  
 (d) Pistil—carpels numerous.

#### 2. Separate the carpels, dissect one :—

- (a) Ovary—apocarpous.  
 (b) Styles—none.  
 (c) Stigmas—as many as carpels.  
 (d) Ovules—one in each carpel.  
 (e) The carpels grow on an enlarged top of the flower stalk.

To this top, let its form be what it may, the name *receptacle* is usually given.

### A COMPARISON.

1. In conclusion we may just notice the likeness and unlikeness of this flower to some previously observed :—

#### (a) To the Buttercup :—

##### *Likeness :—*

- (1) In the numerous carpels and stamens.  
 (2) In the five separate petals.  
 (3) In the carpels, each containing one ovule.

##### *Unlikeness :—*

- (1), (2) In the stamens and petals growing round instead of below the ovary.  
 (3) In the union and number of the sepals.



(b) To the Pink :—

*Likeness :—*

- (1) In the united sepals.
- (2) In the number of separate petals.

*Unlikeness :—*

- (1) In the number of sepals and shape of the calyx.
- (2) In the number and union of the carpels.
- (3) In the number and place of growth of the stamens.

(c) To both :—

*Likeness :—*

- (1) In having five separate petals.

*Unlikeness :—*

- (1) In having the stamens and petals inserted on the calyx.

*New Terms.* At this point it may be well to learn four new terms which we will use in future as occasion may require. Now for united or separate carpels, we have the terms syncarpous or apocarpous, and as we have just seen a calyx may be made up, in one flower, of *separate*, and in another, of *united* sepals, we have two similar terms, viz., *aposepalous* and *gamosepalous*, the prefix *gamo* meaning *united*. Thus, we speak of a gamosepalous calyx, or an aposepalous one. In the same way we speak of an apopetalous corolla, or a gamopetalous corolla. As an exercise in the use of these words try to classify the flowers of the foregoing lessons, thus :—

(a) Corolla apopetalous—buttercup, columbine, silverweed.  
gamopetalous—primrose.

(b) Calyx aposepalous—buttercup, wallflower, &c.  
gamosepalous—primrose, pink, silverweed.

## LESSON XVIII.

### A WILD ROSE.

*Wild roses carefully gathered just opening, stems and leaves; or (according to season) the same of the cherry, crab apple, sloe (blackthorn), or Hawthorn; schedules.*

#### THE PLANT.

1. Every one who has walked along a country lane is more or less familiar with the wild roses of the hedges.

Let us notice now some features of the plant:—

- (a) The stems are slender, woody, branching, and covered with prickles, which are in some kinds *hooked*.
- (b) The leaves are compound, pinnate, and stipulate.

### FLOWER IN SECTION.

1. Before dissecting it will easily be observed that:—

- (a) The petals are five in number, large and almost round, with a wavy notch in the margin.
- (b) The stamens are numerous.
- (c) The sepals are long, pointed, and green (dog rose).
- (d) Underneath the corolla and calyx there is a lump like a swelling of the stalk.

2. Cut the flower vertically as previously directed, dividing the swollen part under the calyx; observe:—

- (a) The stamens and petals grow on the calyx as in silverweed.
- (b) The swelling of the stalk is hollow and filled with long fibre-like bodies.

3. With needle, knife, or clean pen, remove a few of the bodies and notice:—

- (a) Each has a small knob at the top and a larger and harder one at the bottom. (Cut open the lower knob.)
- (b) The lower one contains a small body like an ovule.

That is exactly what it is, and hence we may see what these knobbed fibrous bodies are.

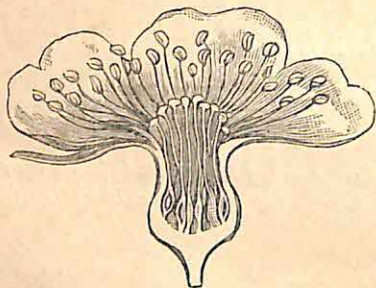


Fig. 84. Vertical section through the middle of a Wild Rose; the carpels are shown in the hollow receptacle, two of them being cut to expose the ovules.

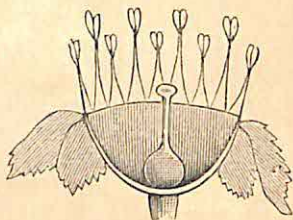


Fig. 85. Diagrammatic representation of a Cherry Flower, showing its one carpel in the hollow receptacle (petals removed).

4. Compare a cherry flower, or notice the drawing of one as in Fig. 85. There the pistil consisting of one carpel is seen standing in the hollow top of the stalk. This hollow is called the *receptacle*; in silverweed we saw it was a lump or swelling. So of the rose we may conclude:—

- (a) The pistil consists of numerous separate carpels.
- (b) Each carpel contains one ovule, and has a long style with a knobbed stigma.
- (c) The whole pistil is contained within a hollow receptacle.

### PARTS OF THE FLOWER.

1. We have now little more to find out about our flower. Examine each part in order and schedule as on the following page:—

*Note.* Garden roses have more than five petals. Let one be examined and it will be found that its stamens are few and weak. Moreover, there may often be seen petals which seem to be half stamen, or stamens half petal. The fact is, that the extra petals are stamens which have grown as such, some of them being neither the one nor the other. Thus are *double* roses formed. From this and other instances, as in the water lily, it is inferred that all petals are stamens modified to fulfil the function of attraction, so as to aid the stamens to perform their work.

In double roses, little or no pollen is produced. The object of those who cultivate such flowers is to get nothing but petals, and new plants are raised, not from seeds, but by budding or grafting on stocks of cultivated or wild roses.

### QUESTIONS.

1. How could you distinguish a silverweed flower from a buttercup?
2. There is a common plant that grows with runners and has small yellow flowers. If you can find one describe its leaves ~~and flowers and say~~ which they more closely resemble—the buttercup or silverweed.
3. Describe the wild rose plant. Would it form a good place for a bird's nest? Why?
4. Examine a bramble flower. Notice:—
  - (a) How many petals, stamens, and carpels it has.
  - (b) Where the stamens grow.
 What flower that you know does it resemble?
5. Write an account of the bramble in the form of a fairy tale.



## FLOWER SCHEDULE.

| Organ.  | Parts.                | No.                  | Cohesion.                                                    | Where inserted.          | Remarks—<br>Shape, colour, etc. |
|---------|-----------------------|----------------------|--------------------------------------------------------------|--------------------------|---------------------------------|
| Calyx   | Sepals                | 5                    | Gamosepalous                                                 | On edge of<br>receptacle | Long, pointed                   |
| Corolla | Petals                | 5                    | Apopetalous                                                  | Round pistil             | Saucer-shaped                   |
| Stamens | Anthers<br>and stalks | $\infty$             | Separate                                                     | "                        | —                               |
| Pistil  | Carpels               | $\infty$             | Apocarpous                                                   | In hollow<br>receptacle  | —                               |
|         | Ovary cells           | $\infty$             | <i>Name</i> —Dog Rose.<br><i>Date</i> —<br><i>Locality</i> — |                          |                                 |
|         | Styles                | $\infty$             |                                                              |                          |                                 |
|         | Stigmas               | $\infty$             |                                                              |                          |                                 |
|         | Ovules                | 1 in each<br>carpel. |                                                              |                          |                                 |

## LESSON XIX.

## PEA-FLOWERS.

*Flowers of everlasting or sweet pea, and portion of plant; or flowers of garden pea, scarlet runner, thurnum, lupin, broom, gorse (furze), vetch, lotus or restharrow. Any or as many of these as can be had, according to the season.*

**Lupin.** *A purple or white flower, grown in old gardens.*

**Lotus.** *An orange-yellow flower, growing on sunny banks (called also bird's foot trefoil).*

**Restharrow.** *A pink and white flower, spiny stem, with disagreeable odour. All have the characteristic flower as described below.*

## GENERAL CHARACTERS OF PEA PLANT.

1. Taking the sweet or everlasting pea (one being an annual, the other a perennial), we observe:—

- (a) The stem is slender, herbaceous, winged.
- (b) The leaves are compound, pinnate, stipulate, and end in tendrils.
- (c) The tendrils are the midribs of the unformed leaflets, and help the plant to climb.

2. This plant is not found wild, but is cultivated for its handsome clusters of sweet smelling flowers. The wild species have smaller flowers, generally yellow.

## THE FLOWER—CALYX AND COROLLA.

1. Let us carefully examine our specimens before dissecting them. Perhaps the flower this seems most to resemble is the pansy, owing to the bend in the stalk and the large spreading petals facing us as we hold up the flower in its natural position.

2. Evidently only the calyx and corolla can be seen, and of these the following observations can at once be led out:—

- (a) Calyx—sepals five, gamosepalous.
- (b) Corolla—irregular.

3. Holding the flower in its natural position, notice the upper

back petal, then the sides, and lastly the lower or front one; apparently we have :—

- (a) A large back petal.
- (b) Two side petals, smaller.
- (c) A boat-shaped petal in front.

4. It is usual to speak of this boat-shaped part as a *keel*, of the two side petals as *sails*, and of the large upper one as a *standard*. We may notice as a first difference, that while the pansy had two back petals, this flower has but one.

5. Examine any of the other flowers suggested that may be at hand, and observe :—

- (a) Standard.
- (b) Two sails.
- (c) Keel.

### CHARACTERISTIC SHAPE OF COROLLA.

1. From a fancied resemblance of these flowers to butterflies, such corollas have been called, from the Latin word *papilio*, meaning a butterfly, *papilionaceous*. Perhaps no shape of corolla is more remarkable or more easily recognised. The standard is not in all flowers of this kind so large and spreading as in the pea, but the keel can always be plainly seen with the two side wings or sails. Get a specimen of white or red clover, take off from the cluster of flowers just one, and look carefully at its corolla.

2. This papilionaceous corolla then marks a difference in this flower from all others we have hitherto observed, and we may go further, and say that all plants having this kind of corolla are considered to be closely related to each other; and they form a most useful class of plants.

The flower has other important characters, but we must leave it to another lesson to discover them.



## LESSON XX.

## SWEET PEA.

*Flowers as in last lesson, two for each pupil. Those of sweet pea being large, will be best to show all the characters, especially on a first inspection. The others may be used for scheduling exercises, both now and later. Schedules.*

## THE FLOWER—COROLLA.

1. Remove the petals one by one, beginning with the large one; take off the keel last, carefully easing it away, so as not to break it. It has *two* claws, from which we infer that it is made of two petals, the limbs of which have grown together. This then makes the petals five, like the sepals; and the corolla is considered apopetalous, because the petals are all separate where they are inserted.

2. We thus summarize:—

(a) Calyx—five sepals, gamosepalous.

(b) Corolla—five petals, apopetalous, papilionaceous.

## THE FLOWER—STAMENS AND PISTIL.

1. We have now left what was inside the keel, viz., a column or tube, with a fringe of anthers at the end. Here then are the stamens.

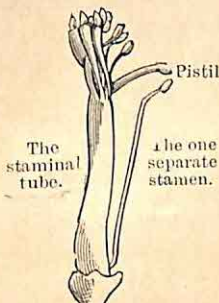


Fig. 86. Stamens and pistil of Pea-flower.

2. With the aid of knife or needle, it will be found that one of these can be lifted up from the rest, as shown in Fig. 86. Now insert knife or needle in the opening left by the removal of this stamen, and lift up what is contained within. We find :—

- (a) All the stamens but one form a tube.
- (b) This tube is formed by the union of the stalks of the stamens.
- (c) There are nine stamens thus united, and one free, *i.e.*, the stamens are in *two bundles*.
- (d) The pistil is within the staminal tube.

3. Cut away the stamens and examine the pistil :—

- (a) The pistil lies horizontally, and has a curved style bringing its stigma to a vertical position just peeping out of the keel. Thus it stands in the way of insects entering the flower.
- (b) The ovary is one-celled, and single, and contains a row of ovules.

It consists of one carpel only.

## THE FLOWER IN SECTION.

1 What we have not seen we can now best discover by cutting a flower vertically through the middle. All the parts are seen in their relative position as shown in Fig. 87. Make a drawing from the section.



Fig. 87. Vertical section through middle of a Pea-flower.

2. Notice where the stamens and petals are inserted—round the ovary.

8. If a broom or gorse flower be examined, the staminal tube will be found to be complete, that is, all the stamens are united into one bundle.

1. We can now summarize and fill up the schedules:—

- (a) Calyx—sepals five, gamosepalous.
- (b) Corolla—petals five, apopetalous, papilionaceous.
- (c) Stamens—ten, in two bundles, 9+1, united by the stalks, *anthers separate*.
- (d) Pistil—one carpel, with curved style and several ovules.

### SUMMARY.

2. We thus see the special characters of this flower are:—

- (a) Papilionaceous corolla.
- (b) Ten stamens in two bundles (or one).
- (c) Pistil of a single carpel.

## LESSON XXI.

### A FOXGLOVE.

*An adequate number of specimens of flowers, and, at least, one of the plant. Schedules.*

#### THE PLANT AND ITS NAME.

1. The foxglove is a tall, handsome plant, especially when seen in its natural home amongst the tall grasses, above which it rises, and with the hedge of hawthorn and bramble for a background.

2. Notice:—

- (a) The stem is erect and from three to six feet high.
- (b) The leaves are large and covered with fine hairs, which make them soft to the touch.
- (c) The flowers are bell-shaped and hang mouth downwards.
- (d) The stem when crushed, or broken, has a peculiar odour.

3. Children often amuse themselves by putting their fingers



into these bell or *glove*-like corollas, and, perhaps, think that the name is derived from this playful use of the flower. But this does not account for the word *fox*. It is really a contraction for *folks*, and the word means *folks'-glove*, i.e., fairies' glove.

### THE FLOWER IN DETAIL.

1. Hold a flower by its stalk, and with finger and thumb carefully remove the corolla, which comes away very easily. Though apparently bell-shaped, it has not both sides, the upper and lower, alike; it is irregular and two-lipped. Cut or slit it down one side from top to bottom and open out:—

- (a) The corolla is gamopetalous, but the number of petals is not evident.
- (b) It is irregular and two-lipped, with an open mouth, the lower lip projecting beyond the upper.
- (c) The stamens are *four*, and they grow *on the corolla*.
- (d) Two stamens are a little longer than the other two; all have long stalks, and the anthers are placed close together at the back of the corolla.
- (e) The long stamens grow from the front, and shorter ones from the sides of the back of the corolla.
- (f) *No stamen grows at the middle of the back of the corolla.*

2. Turn now to the other part of the flower:—

- (a) The calyx—sepals five, gamosepalous.
- (b) The ovary is pear-shaped and has a long slender style with stigma club-shaped.

Cut the ovary transversely and observe:—

- (c) The ovary is two-celled.
- (d) Each cell contains numerous ovules attached to an *axile placenta*.
- (e) The ovary is syncarpous and made up of two carpels.

### SUMMARY.

Fill up schedule for the flower noting:—

- (a) Calyx, five sepals, gamosepalous.
- (b) Corolla, five petals (inferred from the five sepals and a comparison with the flowers of other related plants, especially Mullein), gamopetalous.

(c) Stamens four, two long and two short, on the corolla.

(d) Pistil, two carpels.

ovary, syncarpous.

style one, ovules, numerous.

placentation, axile.

This plant yields a poison.

## LESSON XXII.

### THE SNAPDRAGON AND ITS COROLLA.

*An adequate supply of flowers and a plant; a few foxgloves; in lieu of snapdragon, toadflax, a common yellow-flowered wild plant, may be used. Schedules.*

#### THE PLANT AND ITS NAME.

1. Although sometimes found wild this plant is frequently cultivated in gardens. It should be contrasted with the foxglove:—

(a) Plant small and bushy.

(b) Stem very brittle, herbaceous.

(c) Leaves small, lanceolate, glabrous.

2. Notice the flowers. The corolla is very irregular and of a peculiar shape—two-lipped, but the mouth is closed. With finger and thumb press on each side at the corners of the mouth and it is made to open. The appearance of the flower, especially when made to open and shut, has a resemblance to certain old pictures of dragons, hence the name *snapdragon*.

#### THE FLOWER—COMPARISON WITH FOXGLOVE.

1. It will be found that the corolla can be just as easily removed as that of the foxglove, and the parts as easily observed. Proceed as directed in the last lesson and fill in the schedule.

2. The parts are similar in number and position, the chief difference being in the shape of the corolla:—

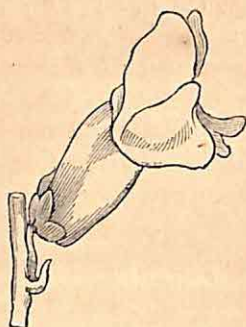


Fig. 83. Flower of Snapdragon, showing labiate corolla (personate).

- (a) The corolla is two-lipped.
- (b) Its mouth is closed.
- (c) The lips are turned back and divided into five lobes.

3. The corolla of the foxglove was also *lipped*; such corollas are said to be *labiate*; so some labiate corollas are open, some closed.

### COROLLA AND STAMENS—A CONTRAST AND A CONCLUSION.

1. It will be well to pause here in order to compare these labiate corollas with, say, that of a rose or a buttercup, and to try to find out what purpose is served by these organs being so different in shape.

2. Consider the foxglove and the buttercup :—

- (a) The buttercup corolla is like a shallow cup and opens upwards; that of the foxglove is tube-like and opens downwards.
- (b) The buttercup has numerous stamens, the foxglove only *four*.
- (c) The buttercup produces much more pollen than the foxglove.

3. A little thought will show us that this must necessarily be so. Owing to the shape of its corolla and the position of its stamens, the buttercup flower must lose much pollen that can never be used to fertilize ovules; wind may blow it out, or the rain wash it away. But, in the foxglove flower, neither rain nor



wind can touch the pollen owing to the shape and position of the corolla. We may, therefore, conclude that such a corolla renders less pollen necessary; for the greater part of the pollen is likely to be effective, and little of it to be wasted.

4. *Two other points* are worthy of notice in this connection; and the *first* is that the size of the foxglove corolla is exactly suited to admit the body of a bee; those who have seen a bee enter one will have been struck by this fact. *The other point* is that the stamens are so placed that the bee's shoulders rub over the anthers and get dusted with pollen as he dives to the farther extremity of the flower. Look at the inside of a corolla without removing it. The four two-lobed anthers lie just under the upper lip, and the stigma is in the midst of them. It is then just as easy for a bee to brush pollen on to this stigma on entering, as to carry it away from the anthers on leaving. But, in order to prevent the flower being fertilized by its own pollen, its anthers do not burst to discharge it until the flower has been open some little time, and there has thus been an opportunity given for it to be fertilized with pollen from another plant.

5. What the foxglove thus secures the snapdragon does also in the same way, with this exception, that the corolla is closed instead of being turned downwards. Those who have watched insects visiting flowers, will have seen that a bee appears to be the only insect that is capable of opening one of these flowers.

## SUMMARY.

1. The foxglove and snapdragon resemble each other in the number, cohesion, and position of the parts.
2. Both have labiate corollas, but that of the snapdragon is closed.
3. These labiate corollas protect the pollen from waste, and so, few stamens are found in these flowers.
4. They are also specially fitted for the visits of special insects, viz., bees.
5. The stamens and stigma are so placed as to secure the most ready fertilization of the ovules by the insect, to the visits of which their corollas are adapted.

Thus, we cannot but consider such flowers as these, of a higher kind than the buttercup or rose, seeing that not only is the corolla specially shaped, but the stamens and stigma are specially arranged, to get the work of these organs done in the quickest and most certain way. So the buttercup and rose are simpler flowers in their structure; and, generally speaking, we shall see that flowers with apopetalous corollas are simpler than those with gamopetalous ones. This is not absolutely so, for the pea and the pansy are instances of elaborate flowers with apopetalous corollas.

## LESSON XXIII.

### THE DEAD NETTLE.

*In July or August, the white dead nettle is the most easy to get, the yellow one (the archangel) flowering in May or June. If neither of these is to be had, the hedge stachys will serve. It is a hairy-leaved plant, with reddish-purple flowers. It is often called a nettle, and it may at once be recognised by its strong unpleasant odour. Failing these, mint, horehound, or hyssop of the garden will do. Specimens as before. Schedules.*

#### THE PLANT AND ITS NAME.

1. It should at once be understood that this plant is no nettle at all. It gets its name, *nettle*, from the resemblance of its leaves to those of that plant, and it is then called *dead* because it does not sting.

2. Examine the plant and observe:—

- (a) The stem is square or four-sided.
- (b) The leaves are opposite, alternate pairs being at right-angles.
- (c) The leaves are ovate-lanceolate, serrate, and hairy.
- (d) The flowers are white, and grow in clusters in the axils of the leaves on very short stalks.

3. The name usually given to a *flower-stalk* may be learnt here. A leaf stalk is called a *petiole*, as previously said; a flower stalk





Fig. 89. White Dead Nettle.

is called a *peduncle*. This word, like the other, means a little foot.

### THE FLOWER.

1. Let us now examine this flower, as we have done others, filling in the schedule as we go on. Take off a single flower; the calyx may be seen at once, or better, after the removal of the corolla. *Unless great care is exercised, the style will break off and come away with the corolla.* A vertical section will show the parts in position.

2. The following should be noticed :—

- (a) Calyx—gamosepalous, tubular, with five pointed teeth; sepals, five.
- (b) Corolla—gamopetalous, labiate, upper lip arched, lower lip spreading and forming a kind of platform on which an insect can alight. *Petals* five (inferred as in case of foxglove, and from the five divisions of the lips).
- (c) Stamens—four arranged as in foxglove, under the upper lip, two long and two short.
- (d) Style—one with a two-cleft stigma.
- (e) Ovary—in four parts.

### THE PISTIL.

1. If not already done, make a vertical section through the



Lower lip  
or  
platform.

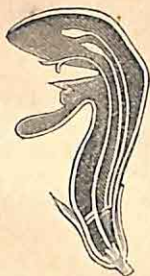


Fig. 90. Vertical section through middle of a Dead Nettle flower, showing the style rising from the bottom of the ovary.

middle of the flower, and notice where the style rises from. Make a drawing in outline of this section, and also one of a horizontal section, showing the four parts of the ovary (or nutlets as they are often called).

2. Cut open the nutlets ; an ovule is found in each.

3. Now what is the number of carpels of which this pistil is made up? The nutlets seem to say four ; the stigmas, two. And for anything you can see, you would have to describe such a pistil as having two stigmas and an ovary of four nutlets, and leave the matter there. But botanists have come to the conclusion that the stigmas tell the true story. The carpels are two, and the ovary is syncarpous ; but the two carpels have partially separated, and as there were but two ovules in each, a division has formed between them, separating each carpel into two half-carpels. If you compare the carpel with a leaf, as we have done before, and imagine the midrib and margin to join, the top grown down so as to form two cells, and then these cells to separate by a division or splitting through the middle of the partition, you will have something similar to what we are now considering. It is only as they get older that the half-carpels separate.

4. The pistil then is :—

(a) Syncarpous, of two carpels, having

(b) An ovary which separates into four half-carpels, each holding one ovule.

## LESSON XXIV.

## THE HARE-BELL.

"The azur'd harebell."

Shakespeare.

*Specimens of this plant and flowers; if possible, some should be gathered on which the radical leaves still remain. Flowers of either the Canterbury bell or the great campanula will do; these two are often cultivated in gardens. Schedules.*



Fig. 91. Blue-bell or Hare bell, showing cordate radical leaves.

## CHARACTERS OF THE PLANT.

1. This plant is the true blue-bell. It is also called the hare-bell, and its name is derived from *hare*. But some hold that it should be written *hair-bell*, in which case the name is taken from its fine *hair-like* stems and leaves. It grows on dry banks, upland pastures, and heaths.

2. Let us now examine the plant generally :—

- (a) The stem is thin and slender.
- (b) When broken it discharges a milky juice.
- (c) The radical leaves are round or cordate, the cauline, lanceolate and linear.
- (d) The flowers are blue and bell-shaped, and grow in a cluster at the top of the stalk. The radical leaves wither as the plant grows, and have generally disappeared at the time of flowering, at least, from the flowering stem.

## THE FLOWER.

1. The flower will be best examined, first whole, then in section.

From the flower whole, we may notice :—

- (a) The calyx is gamosepalous, with five long linear points.
- (b) The corolla is gamopetalous, with five broad short lobes.
- (c) The lobes are all equal; the corolla is quite regular.
- (d) There are five stamens and three stigmas (Canterbury bell, five).

2. To ascertain the number of cells in the ovary, make a transverse section of it; be careful to reserve some specimens for a vertical section; observe :—

- (a) The ovary is three-celled (Canterbury bell, five-celled).
- (b) The ovules are attached to the partitions, hence
- (c) The placentation is axile.
- (d) To cut the ovary, the calyx has to be cut through.
- (e) The calyx below the points does not part from the ovary.

3. Now cut a vertical section, and make an outline drawing, as shown in Fig. 92; the following points come into notice :—

- (a) The calyx and the ovary *adhere*.
- (b) The stamens and corolla grow from the *top of the ovary*.



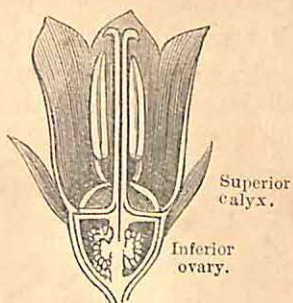


Fig. 92. Blue-bell. Vertical section through the middle of the flower.

4. We have here *two points* which should be specially noted. Hitherto the ovary has always been *free from the calyx*, but in this flower the two adhere together. In such a case the relation of the two is expressed by saying that the calyx is *superior*, and the ovary *inferior*. In the flowers which have gone before, the *calyx* is *inferior* and *ovary superior*. The exact meaning of these two words is *upper* and *lower*, but it must be remembered that although an ovary may be lower than the calyx, it is not *inferior* unless it is *not free* from the calyx; if it is free it is *superior*.

5. The other point is the insertion of the stamens and corolla; not *under* the ovary, as in the pink, pansy, and buttercup; not *round* the ovary as in the rose and pea; but *on* the ovary. This arrangement is only possible with an inferior ovary.

6. We have noticed that the ovary is three-celled. We saw this in the cross section; in the vertical section it could not be seen. Having then three stigmas and a three-celled ovary, we conclude:—

- (a) That the pistil is made up of three carpels.
- (b) That the ovary is syncarpous.

7. The corolla, like the calyx, in this and some other flowers, does not fall away when the flower withers. Such are said to be *persistent*.

## SUMMARY.

Fill in the schedule, noting:—

- (a) Calyx—sepals five, gamosepalous, superior, persistent.
- (b) Corolla—petals five, gamopetalous, regular, persistent.
- (c) Stamens—five, separate, inserted on the ovary.
- (d) Pistil—carpels three, ovary syncarpous, inferior; one style, three stigmas.



Fig. 93. Canterbury Bell.

## LESSON XXV.

### COROLLAS

#### AND THE OTHER FLORAL ORGANS.

*(A recapitulation with some additions.)*

*Some additional terms are given below, not necessarily to be learnt, but for reference, as they are of common occurrence in books on Botany. They are enclosed within brackets.*

*For specimens, provide as great a variety as possible of flowers dealt with in the foregoing lessons.*

#### FORMS OF COROLLAS.

1. As the most striking organ in many cases and the most variable in form, we will try to recall the different-shaped corollas we have so far met with. We have already learnt what its function

is, viz., to attract insects to the flower, and hence it is not only coloured, but also often shaped to suit the particular insect which it is most desirable should visit it.

2. We have also seen what corollas are made up of, and, considering them in respect of the cohesion of these parts, we may divide all corollas into two classes :—

(a) Gamopetalous corollas.

(b) Apopetalous corollas.

And in both these we find with regard to the equality or inequality of the parts :—

(a) Some are regular, e.g., *buttercup*, *rose*, *hare-bell*.

(b) Others irregular, e.g., *pansy*, *pea*, *snapdragon*.

3. Of the APOPETALOUS corollas some are :—

(a) Saucer-shaped like the *rose* (rosaceous).

(b) Cross-shaped like the *wallflower* (cruciform).

(c) Wheel-shaped like the *pink* and *campion* (rotate).

(d) Butterfly-shaped like the *pea* and *broom* (papilionaceous).

(e) Irregular and spurred like the *monkshood*, *pansy* and *violet*.

(f) Regular and spurred like the *columbine*.

4. Of the GAMOPETALOUS corollas some are :—

(a) Two-lipped like the *snapdragon* (labiate, personate).  
and *dead-nettle* (labiate, ringent).

(b) Bell-shaped like the *hare-bell* (campanulate).

## FORMS OF CALYX.

1. With regard to cohesion of sepals, a calyx may be :—

(a) Gamosepalous, or

(b) Aposepalous.

2. A GAMOSEPALOUS calyx in reference to its being free or not free from the ovary is :—

(a) Superior, or

(b) Inferior.

3. An aposepalous calyx is always inferior.

3. In regard to form a calyx may be :—

(a) Tube-like as in the *campion* (tubular).

(b) Bell-shaped as in some *labiate plants*.



- (c) Cup-shaped as in the *foxglove*.
- (d) Double as in the *strawberry*.
- (e) Spurred as in the *larkspur*.

4. With regard to DURATION :—

- (a) Some fall off on the flower opening, *e.g.*, *poppy* (caducous).
- (b) Some fall off when the flower withers.
- (c) Others remain with the fruit, *e.g.*, *primrose* (persistent).

## STAMENS.

1. The two chief characters to be noticed are their arrangement and place of insertion. First, their arrangement :—

- (a) In one or more whorls of two, three, four, or five.
- (b) Four and two arrangement, *e.g.*, *wallflower* (tetradynamous).
- (c) Two and two arrangement, *e.g.*, *dead-nettle* (didynamous).
- (d) In two bundles, 9 + 1, *e.g.*, *pea* (diadelphous).
- (e) In one bundle, 10, *e.g.*, *gorse* or *furze* (monadelphous).

2. With regard to their insertion they are found :—

- (a) Under the ovary, *e.g.*, *buttercup*, *pansy*.
- (b) Round the ovary, *e.g.*, *silverweed*, *rose*.
- (c) Upon the ovary, *e.g.*, *hare-bell*.
- (d) Upon the corolla, *e.g.*, *foxglove*, *primrose*.

## THE PISTIL.

1. In regard to cohesion a pistil is :—

- (a) Apocarpous as in the *marsh marigold* and *rose*; or
- (b) Syncarpous as in the *foxglove*, *hare-bell*, *etc.*

2. A SYNCARPOUS pistil is, with regard to its being free or not free :—

- (a) Superior as in the *foxglove*, *primrose*, *etc.*
- (b) Inferior as in the *hare-bell*.

3. An APOCARPOUS pistil is always superior.

4. A SYNCARPOUS pistil has further in the arrangement of its ovules :—

- (a) A central placentation, *e.g.*, *primrose*, *pink*; or
- (b) An axile placentation, *e.g.*, *hare-bell*, *foxglove*; or
- (c) A walled placentation, *e.g.*, *violet*, *poppy*

## THE WHOLE FLOWER.

1. The ESSENTIAL organs of a flower are :—
  - (a) The stamens.
  - (b) The pistil.
2. The remaining portion is the perianth, which may consist of :—
  - (a) Calyx and corolla, e.g., rose, pansy, etc.
  - (b) Calyx only, e.g., marsh marigold.
3. When all the four whorls are present a flower is said to be complete, but when one (or more) is missing then the flower is incomplete.

## EXERCISES.

*Such flowers as the following, or any already dealt with, should now be obtained and examined as directed in the foregoing lessons and the results entered up in schedule forms, care being taken to note the various characters summarized in the above lesson as they may occur. Specimens of plants examined should, when possible, be dried and afterwards mounted :—* Convolvulus, phlox, honey-suckle, bean, lily, forget-me-not, pimpernel, bramble, potato, nightshade, etc., etc.

## LESSON XXVI.

## A DANDELION.

*If this lesson is given as far in the season as July, it is probable no dandelions in flower will be found, but throughout July, August, and September, there can be obtained anywhere from the roadside or fields, a plentiful supply of flowers much like dandelions, that, for the purpose of this lesson will serve equally well—crepis, cat's-ear, hawk-bit, and hawkweeds—and which appear to differ only in stem and foliage from that plant.*

## GENERAL CHARACTERS.

1. Everybody knows a dandelion, with its bright golden flower and its "clock to tell the time." But it is often confused with a number of other plants that have very similar flowers.

2. We will notice a few points :—

- (a) The "flower" is borne at the end of a simple hollow peduncle.
- (b) The leaves are all radical and form a rosette.
- (c) They are toothed, the teeth pointing downwards (margin runcinate).

3. From the supposed resemblance of these teeth to those of a lion the plant gets its name, *dandelion* being only our English way of saying the French words *dent de lion*, which means *lion's tooth*.

### THE FLOWER-HEAD.

1. Whether we take a dandelion flower or one of those above alluded to, the following characters will, in either case, be equally well seen.

2. At first there appear to be numerous sepals and petals; and a little careful examination shows amongst these apparent petals a considerable number of fine hair-like stalks, each divided into two at the top and curving backwards.

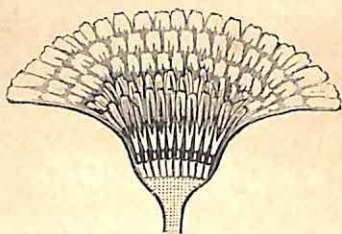


Fig. 94. A Dandelion-like flower-head. Vertical section through the middle exposing the separate flowers.

3. Now cut through the "flower" vertically from the stalk upwards, and a number of petal-like bodies are liberated in the centre. Remove some of these with the knife point and lay them on a slate or paper; select one or two of the largest for closer observation. Notice :—

- (a) Each consists of three parts, a small lump at the base, a tube-like part, and a petal-like part.
- (b) The petal-like part appears to be the upper-part of the tube split open and growing on one side.



- (c) This petal-like part has five small points at its top.
  - (d) From the tube arises the hair-like stalk with its divided curving top.
  - (e) Round the top of the little lump is a ring of very fine hairs.
  - (f) Round the hair-like stalk is a ring of something yellow, from which what appear to be pollen grains can be taken.
4. Sketch the object in outline. Cut open the little lump at the base and it is found to contain a seed or ovule.
5. By this time the conviction will be forming that this object being examined has :—

- (a) An ovary containing an ovule.
- (b) Stamens discharging pollen.
- (c) A style with two stigmas.
- (d) A petal-like portion or corolla, and that therefore,
- (e) It must be a flower in itself.

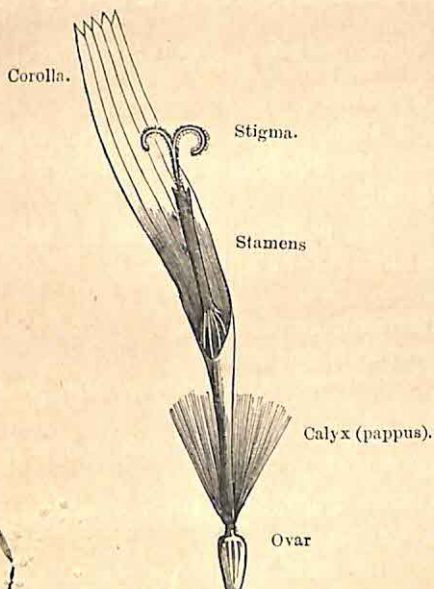


Fig. 95. Flower of Dandelion.

6. This is exactly the case. What we have called a flower is a cluster or head of flowers. What at first was taken to be the

calyx is something else which acts as a calyx to the whole head. We have seen in one or two cases small leaves growing below the flower, and to them have given the name of bracts. Now, here we have a dense whorl or ring of bracts, generally called an *involucre*, and such a flower-head is sometimes called *compound*.

### SUMMARY.

1. A dandelion has a compound flower, or head of numerous flowers.
2. These flowers are surrounded by an involucre of bracts.

## LESSON XXVII.

### DANDELION FLOWERS.

*Specimen as in last lesson ; schedules.*

#### CALYX AND COROLLA.

1. Each pupil should have at least two or three flowers dissected out from the flower-head. Let us now examine one of these more in detail.
2. Recall the chief points observed in the last lesson. We noticed the petal-like part or corolla :—

- (a) It is yellow.
- (b) It has five small points and ribs.
- (c) Its upper part is split open.
- (d) It may be inferred that it is made up of five petals.
- (e) It is gamopetalous.
- (f) It grows from the top of the ovary, its lower portion being a complete tube.

A corolla of such a shape is likened to a strap, and is called *strap-shaped* (or *ligulate*).

3. But where is the calyx ? The ring of hairs growing on the top of the ovary has been noticed, and this is all we have to represent that organ—a calyx of numerous hairs. Is it then aposepalous or gamosepalous ? First, we had better notice its

position with regard to the ovary; these hairs spring out of its sides or walls; the ovary does not stand clearly above the calyx, or in a cup partially formed by it; in other words, the ovary and the calyx are not free from one another, therefore:—

(a) The calyx is superior.

(b) The ovary is inferior.

And, consequently, it is only the upper portion of the calyx which consists of numerous hairs, the lower portion being united with the walls of the ovary, just as was the case in the hare-bell; therefore:—

(c) The calyx is gamosepalous.

4. From what was stated previously, such might be expected to be the case, for it was said that only a gamosepalous calyx could be superior.

### THE STAMENS.

1. These are small and cannot well be seen without the aid of a magnifying glass. Carefully slit open the corolla tube and there should be seen:—

(a) The anthers are united round the style.

(b) They are very long on short stalks.

(c) The stalks are attached to the corolla tube.

(d) There are five stalks.

2. We have before had stamens united by their stalks, but, for the first time, we meet them united by their anthers. Care is required to dissect out these stamens, but they are easily seen if the corolla tube is carefully slit open.

### PISTIL.

1. Cut open the ovary and dissect out the ovule. The chief characters have been already seen:—

(a) A single style with two curved stigmas.

(b) An ovary of one cell containing a single ovule.

2. The question now is, what is the number of carpels? There is not much resemblance to carpels as seen in the pea or columbine, but still no doubt is entertained that this pistil, as



all others are, is made up of carpels, and the question is, as before, what is to guide us, the stigmas or the cells of the ovary? The conclusion of botanists is that the number is two as shown by the stigmas; that they have become so completely joined in the ovary that there is, not only one cell, but also only one ovule. If we examine any number of flowers of the dandelion kind we shall always find the two-cleft stigma; *i.e.*, of course when the stigma is fully matured.

3. It may here be noticed that in the flower-head the outer flowers open first, the inner ones last.

### SUMMARY (for schedule).

1. Calyx—sepals (?) (perhaps five as there are five petals and five stamens) gamosepalous and superior, of numerous hairs.
2. Corolla—petals five, gamopetalous, on the ovary, strap-shaped.
3. Stamens—five on the corolla, anthers united.
4. Pistil—carpels two (?) ovary, syncarpous, one-celled, one ovule, inferior, style one, stigmas two.

## LESSON XXVIII

### A SUNFLOWER.

*Two or three sunflowers will be sufficient for a large class; the "dark-centred" ones being the best for the purpose. Instead, ox-eye daisies, marigolds, or ragwort will do.*

#### RAY AND DISK.

1. Sunflowers are not native plants, though widely grown as garden flowers. The name is probably due to the sun-like appearance of the flower. That the flower always turns to the sun, as is sometimes stated, is only a fanciful notion not borne out by experience.

2. Look now at the "flower" and notice:—

- (a) There is a central flat part, and
- (b) A ring of large yellow petal-like leaves.
- (c) Outside these an involucre of strong green and hairy bracts.

3. There is evidently some resemblance here to the dandelion, but the spreading yellow leaves and the flat centre are, at any rate, different; these two parts are known as the *ray* and the *disk*; thus a sunflower has:—

- (a) A yellow ray.
- (b) A large darker-coloured disk.

### STRUCTURE OF THE FLOWER-HEAD.

1. Cut through the centre vertically, dividing the head into halves, quarters, or even eighths if necessary. We shall now find what this ray and disk are made of. Notice:—

- (a) The disk is made up of a great number of small flowers.
- (b) The corollas are tube-like (or tubular).

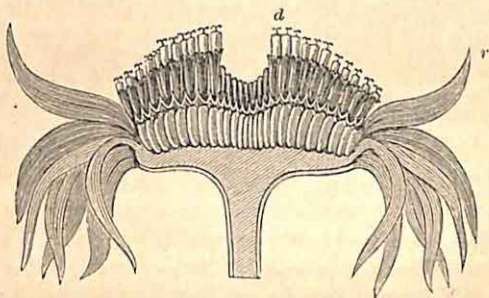


Fig. 96. Sunflower, vertical section through centre, showing disk flowers (*d*), ray flowers (*r*), and involucre (*b*).

2. Now look at the ray; take out one of the yellow leaves, being careful not to break it away from what belongs to it. Observe:—

- (a) The yellow leaf closes into a very short tube below.
- (b) At the bottom is, apparently, an ovary.
- (c) A short style projects from the mouth of the tube.
- (d) The whole bears some resemblance to a dandelion flower.

3. The ray, like the disk, is made up of flowers; each yellow leaf is a corolla similar to those we found in the dandelion, *i.e.*, strap-shaped or *ligulate*.

## SUMMARY.

1. A sunflower consists of a ray and a disk.
2. Each is made up of a number of separate flowers.
3. The ray flowers have large ligulate corollas.
4. The disk flowers have small tubular corollas.

## LESSON XXIX.

## DAISIES.

"That well by reason it men callen may  
The daisie, or else the eye of day."  
Chaucer.

"Meadows trim with daisies pied."  
Milton.

*Daisies, ox-eye daisies, and sunflower. A drawing of a single flower (cut open) on a large scale should be prepared to show positions of stamens, etc.*

## DAISY FLOWERS.

1. No flower is better known than the little daisy. The following points will be familiar:—

- (a) The plant grows with a creeping stem, and has small spoon-shaped (spathulate) leaves.
- (b) The flowers have a white ray and yellow centre.
- (c) As they close at night, they show the white ray tipped with crimson underneath.

2. The large ox-eye daisies are almost as familiar, and so much do they resemble the small daisy, that there is little wonder they have taken the same name. Marguerites, too, they are called, being, in fact, a kind of chrysanthemum. The differences between these daisies, beyond the more obvious one of size, habit of stem, and form of leaf, need not be entered into here.

3. There is no doubt that the name was first given to the little daisy on account of its habit of closing at night and opening with the coming of day.

## STRUCTURE OF THE FLOWER-HEADS.

1. It will hardly be necessary to dissect one of the flowers to see:—



- (a) Each daisy flower is a head of flowers like the sunflower.
- (b) The white part is the ray, and the yellow the disk.
- (c) The whole is surrounded by an involucre.

2. Dissect specimens ; the parts will be better seen in the ox-eye daisy, and comparison should be made with the sunflower as the examination proceeds. The ray flowers have :—

- (a) Ligulate corollas.
- (b) A style with two-cleft stigma.
- (c) No stamens.
- (d) No calyx (apparently). In sunflower and ox-eye daisy there is a raised border.

The calyx is in fact combined with the ovary, although it does not grow into points above it, hence :—

- (e) The ovary is inferior and the calyx superior.



Fig. 97. Single flower from disk of Sunflower.

3. The disk flowers have :—

- (a) Tubular corollas, gamopetalous, five-pointed.
- (b) Style, stigmas, ovary, and calyx, as in the ray flowers.
- (c) Five stamens united by their anthers round the style, their stalks inserted on the corolla.

4. These points cannot all be seen without the aid of a good glass in the tubular flowers of the daisy, and even in that case delicate manipulation is necessary ; but in the sunflower, the parts are sufficiently large, and it will be possible to observe the parallelism between the two.

## COMPOSITE FLOWERS.

1. We are now in a position to notice one or two facts about the flowers we have been studying in the last three lessons :—

- (a) Each so-called flower is a head of flowers
- (b) In some heads the flowers are all alike in shape.
- (c) In some there is a ray of flowers with ligulate corollas, and a disk of flowers with tubular corollas.
- (d) In both cases all are surrounded by an involucre.

2. Now such heads as these are said to be *compound*, to distinguish them from what are called *simple* flowers, like the buttercup and rose. But a better name than this is *composite*, by which we mean that each so-called flower is a *composition* of flowers, or consists of flowers *placed together as one*. So :—

Dandelions, hawkweeds, daisies, sunflowers, marigolds, are composite flowers.

N.B. Observations should be made and records kept of flowers that close at night and their colours, for it is obvious that such cannot be visited by nocturnal insects.

## LESSON XXX.

## COMPOSITE FLOWERS.

(RAYED FLOWERS.)

*Garden marigold, blue-bottle cornflower, and daisies.*

## GARDEN MARIGOLD.

Examine the flowers as previously directed, and observe :—

- (a) The marigold is a composite flower.
- (b) It has a ray and a disk.
- (c) The ray flowers have *pistils* but no stamens.
- (d) The disk flowers have *stamens* but not *pistils*.

## CORNFLOWER (BLUE-BOTTLE).

1. Examine this flower in the same way; observe :—

- (a) The cornflower is a composite.
- (b) It has large blue ray flowers.

2. Remove the ray flowers, and examine the disk flowers first:—

- (a) The corolla of each has five long points (five petals, gamopetalous).
- (b) The calyx is represented by a ring of short hairs.
- (c) The anthers are united round the style, and are black.
- (d) Ovary inferior, stigmas two.

3. The ray flowers scarcely appear to be flowers, for they have:—

- (a) No stamens.
- (b) Neither style nor ovary.

But they are, in fact, barren flowers.

### PURPOSE OF RAY AND DISK.

1. We may pause here to inquire what purpose is served by these flowers growing in the form of ray and disk, or with barren ray flowers, as in the last example.

2. First, then, recall what has been learnt about corollas:—

- (a) It is necessary to the welfare of the seed which is to grow, that insects should be attracted.
- (b) Corollas are organs of attraction.

3. Now consider the daisy. Suppose there were no ray flowers; the disk flowers would not be seen by any means so easily as they are now. Or take the case of the great sunflower; the dark centre would scarcely attract any insect. If then there were not these ray flowers, the disk flowers must either run the risk of being much less visited, or else each separate corolla must be larger and more attractive.

4. Thus then we see:—

- (a) A daisy has a great number of small unattractive flowers.
- (b) Insects are attracted to these small flowers by an outer ring of flowers, whose corollas grow larger and do the work of attraction for the whole head.
- (c) These attractive flowers have no stamens (in the cornflower neither stamens nor pistil).

5. The work, then, is divided, the disk flowers generally having stamens and pistil, and producing seeds, the ray flowers having



no stamens, but, instead, larger corollas, to entice insects to visit the flower-head; for an insect having alighted, is not likely to fly away until he has inserted his trunk in every flower ready to receive it. And then, think how much less trouble it is for the insect to be able to gather honey from, perhaps a hundred flowers, without further flying or seeking! It is, indeed, an example of co-operation and division of labour amongst the flowers of the plant. The bees, with their males, female, and workers (or neuters), furnish a parallel in the insect world.

6. With regard then to these ray flowers, we may notice:—

- (a) Those of the daisies and sunflowers produce no stamens.
- (b) Those of the marigold are similar, but the disk flowers have not pistils.
- (c) Those of the cornflower are entirely given up to the work of attraction, having neither stamens nor pistils.

7. These flowers then, we see, are still more complex or much less simple than such as the rose, buttercup, or even foxglove. The opening of the stigmas should be observed also, and it will then be seen by what means self-fertilization is prevented. The stigmas do not open until clear of the anther tube, through which the style grows so as to expose them above.

### EXERCISE.

**OTHER RAYED FLOWERS.** *Some other rayed flowers should be examined, and a schedule filled up as given below. Examples are:—*

**Corn Marigold**, a flower all yellow, leaves whitish green; often cultivated in gardens.

**Michaelmas Daisy**, not a native, grown in gardens, rays of a pretty lilac colour, plant herbaceous, almost woody and bushy, leaves dark-green and lanceolate or linear.

**Ragwort**, a pretty yellow-rayed flower, some species common everywhere in fields and by roadsides, plant erect, two to three feet, leaves much divided.

These all flower in late summer or early autumn.

## FLOWER SCHEDULE.

*Composite.*

R = ray. D = disk flower.

| Organ.  | Parts.      | No.        | Cohesion.                                  | Where inserted. | Remarks.            |
|---------|-------------|------------|--------------------------------------------|-----------------|---------------------|
| Calyx   | Sepals      | R ?<br>D ? | Gamosepalous                               | Superior        |                     |
| Corolla | Petals      | R 5<br>D 5 | Gamopetalous                               | On the ovary    | R white<br>D yellow |
| Stamens | Anthers     | R 0<br>D 5 | Anthers united                             | On the corolla  |                     |
| Pistil  | Carpels     | R 2<br>D 2 | Syncarpous                                 | Inferior        |                     |
|         | Ovary cells | 1          | Name—Wild Chamomile.<br>Date—<br>Locality— |                 |                     |
|         | Styles      | 1          |                                            |                 |                     |
|         | Stigmas     | 2          |                                            |                 |                     |
|         | Ovules      | 1          |                                            |                 |                     |

## LESSON XXXI.

## COMPOSITE FLOWERS.

## THISTLES AND "EVERLASTINGS."—A SUMMARY.

*Thistles, knapweed (called also hardheads, very common, thistle-like, but without prickles); any kind of "everlasting" flower, asters, dahlias, hawkweeds, and groundsel.*

## THISTLES.

1. Take specimens of thistles or knapweed and observe:—
  - (a) A thistle has long narrow pinnatifid leaves having very prickly margins.
  - (b) In some thistles the leaves are not only sessile, but grow down the side of the stem below the point of insertion.
2. Examine a flower-head; it consists of:—
  - (a) An involucre of numerous prickly bracts, enclosing
  - (b) Numerous flowers.
3. Take out some of the flowers and observe:—
  - (a) All the flowers have tubular corollas.
  - (b) The calyx, as in the dandelion, takes the form of numerous silky hairs.
  - (c) There are also similar hairs growing on the receptacle between the flowers.
4. The hairs growing from the top of the ovary as the free part of the calyx are in all these composite flowers called a *pappus*. If the hairs of the *pappus* of some thistles be examined with a magnifying glass they will be found to be branched and not simple as in others.
5. If a knapweed flower be examined it will be found:—
  - (a) That it resembles a thistle in having all its flowers with tubular corollas.
  - (b) That it differs in having only a minute pappus and a dark, hard, scaly involucre.



## "EVERLASTING" FLOWERS.

1. These flowers are so called because instead of falling when gathered they become dry and chaffy and can be kept for many years. They are not native English plants, though easily grown in gardens.

2. Examine a flower and observe:—

(a) The flower is a composite.

(b) The involucre consists of many layers of dry scaly bracts.

It is these bracts which are persistent and give to the flower its special character.

## SUMMARY.

1. We may now make a little summary of some of the facts learnt about composite flowers. First, with regard to the common characters:—

(a) All the flowers grow in dense heads.

(b) The flowers of each head are surrounded by an involucre, which encloses them when in bud.

(c) The flowers are generally perfect, but some are only staminate, others only pistillate.

(d) The corollas are either ligulate or tubular.

(e) The pistil (when present) has two stigmas and a one-celled inferior ovary containing one ovule.

(f) The stamens (when present) are always *five*, growing on the corolla, and united by their anthers round the style (such anthers are called *syngenesious*).

(g) The calyx appears as either a raised border or a pappus of numerous hairs.

2. With regard to the flower-heads:—

(a) Some are composed entirely of flowers having *ligulate corollas*, e.g., dandelion, hawkweed, hawk-bit, hawk's-beard, cat's-ear, salsify, etc.

(b) Some entirely of flowers having *tubular corollas*, e.g., thistles, knapweed, groundsel, burdock, and coltsfoot, which flowers in early spring before its leaves appear.

(c) Others have a *disk of tubular flowers* and a *ray of ligulate flowers*, e.g., daisy, Michaelmas daisy (an American aster), sunflower, ragwort, corn marigold, wild chamomile, yarrow, marigold, African and French marigolds (really Peruvian), Jerusalem artichoke, etc.

- Note.* 1. Flowers of the composite kind are often spoken of as double when the disk flowers grow with ligulate instead of tubular corollas.
2. There are known in the world about 9,000 species of plants which bear composite flowers; of these, 132 only, belong to the British Isles. The composites are about one-tenth of all the flowering plants known.

## LESSON XXXII.

### INFLORESCENCE.

*Specimens of any of the following groups:—*(1) *blue-bell, lily of the valley, foxglove, snapdragon, wallflower*; (2) *stitchwort, campion, chickweed*; (3) *cowslip, ivy*; (4) *a composite or clover*; (5) *hemlock, angelica, parsnip, parsley, hogweed*; (6) *a plantain*.

#### WHAT AN INFLORESCENCE IS.

1. If we take up a stem bearing flowers of, say, the foxglove, we have no name by which to speak of it as a whole; it is a stem of flowers, but in Botany we call it the *inflorescence* of the plant. In this lesson we shall consider some of the different kinds of inflorescence.

2. First then notice the inflorescence of the foxglove (or blue-bell).

(a) There is a tall stalk on which the flowers are inserted.

(b) Each flower has a little stalk of its own by which it is attached to the greater stalk.

This greater stalk is called the *peduncle*; we have used the term before; it is the name given to the flower-stalk that springs from the plant. Sometimes the peduncle has only one flower on it as in the silverweed, but often it is branched as in the example before us; then the branches or smaller flower stalks are called *pedicels*. Both words mean *little feet* or *foot-stalks*.



Fig. 98. Inflorescence—a raceme—of Blue-bell (hyacinth). When growing, the flowers usually fall the other way, but they have been turned to show pedicels and bracts.

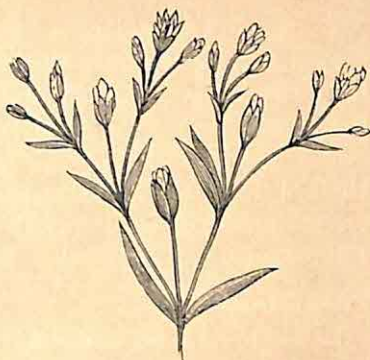


Fig. 99. Inflorescence—a cyme of Stitchwort.

## KINDS OF INFLORESCENCE.

1. In the example just quoted we have seen that the peduncle bears several flowers, but we referred to the silverweed in which the peduncle has only one flower; other instances are the snow-drop and daffodil. We may then say of these two kinds of inflorescence that:—

- (a) One is clustered.
- (b) The other solitary.

2. Now it is of the clustered inflorescence that something may be observed. Compare one of group (1) with one of group (2); notice with regard to (1):—

- (a) The peduncle is like a central axis.
- (b) The pedicels spring from the central axis all the way up.

3. Now examine one from (2), say the stitchwort, as in Fig. 99. Follow the axis up from the bottom; observe:—

- (a) The central axis soon ends in a flower.
- (b) It branches out on each side a little below the flower.
- (c) Each branch terminates in a flower, and branches out again on each side as before.

This process of branching is continued as long as the plant can go on growing upwards,



4. Now the first kind of branching is called a *raceme*, and the second a *cyme*, and all clustered inflorescences are of one of these two kinds. The cyme is not so often seen, though many trees branch in this way, and there are two special kinds of cymes which will not for the present be considered. The other kind of branching, the raceme, or racemose branching, has several modified forms which are common and can easily be understood.

### THE RACEME.

1. A *raceme* then essentially consists of a peduncle, having flowers growing from it on pedicels.

2. If these pedicels are absent so that the flowers are sessile on the peduncle, as in the broad-leaved plantain (a common roadside weed, the seeds of which are often given to cage birds), we have what is called a *spike*.



Fig. 100. Inflorescence—umbels—of Cowslip.



Fig. 101. Compound umbels.

3. If the spike is slender and drooping then it is called a *catkin* (Fig. 68). The term is also applied to some like the "palms" of willow which do not droop.

4. If the pedicels all spring from one point in the peduncle as

in the cowslip (Fig. 100), then the inflorescence is called an *umbel* (compare umbrella); and if, as in hemlock, parsnip, parsley, and a number of other plants (Fig. 101), the pedicels branch again, so that the secondary pedicels all arise from one point in the pedicel, we have a *compound umbel*.

5. If again we think of the spike and imagine all the sessile flowers to grow from one point, or the peduncle to be so broadened that they could all grow from one level, or from nearly the same level, we have the *head* as seen in composites (Fig. 96), and the clover (Fig. 102).

6. Sometimes in the ordinary raceme, as it were, the pedicels have branched bearing two or more flowers on shorter or longer secondary pedicels; such an inflorescence is called a *compound raceme* or *panicle*; it is seen in the grape vine, and in oats, and several grasses.



Fig. 102. Inflorescence—a head—of Clover.

7. A raceme in which the pedicels are so long as to bring all the flowers up to one level, though springing from different heights in the peduncle, is called a *corymb*. Candy-tuft is an example.

## BRACTS.

These have already been noticed in various instances, it is now time to say what they are. They may be described as leaves, generally smaller and of a different shape than the ordinary foliage, that grow on the peduncles or pedicels. Thus they are part of the inflorescence, which is said to be *bracteate* when they are present, but *ebracteate* when they are absent.

## SUMMARY.

Inflorescences are :—

1. (a) Bracteate or  
(b) Ebracteate.
2. (a) Solitary or  
(b) Clustered.

Clustered inflorescences are :—

1. Cymose or
2. Racemose, including :—
 

|                      |                              |
|----------------------|------------------------------|
| (a) Raceme.          | (d) Umbel or compound umbel. |
| (b) Spike or catkin. | (e) Corymb.                  |
| (c) Head.            | (f) Panicle.                 |

## EXERCISE.

*Outline drawings should be made of the above forms, and familiarity with them acquired by examining and describing as many specimens showing the full inflorescence as possible. Dried specimens will do as well as fresh for this purpose.*

## LESSON XXXIII.

## FLOWERS OF GRASS.

*Rye grass or darnel (Fig. 103) in sufficient quantity to supply each pupil with a specimen; flowers of a few other grasses, e.g., the bent grass of which Fig. 104 shows a single flower; it is a coarse-leaved grass, with a spreading panicle, each flower on a pedicel alone, the whole light and cloud-like. Both flower at the end of summer.*

## RYE GRASS OR DARNEL.

1. The chief features of grass plants have been observed in a former lesson, and should be recalled here.

2. Take up now the part which looks like a small green ear of corn. This, we shall find, consists of flowers, for we may see stamens hanging out. What part of the plant then is it? The inflorescence,



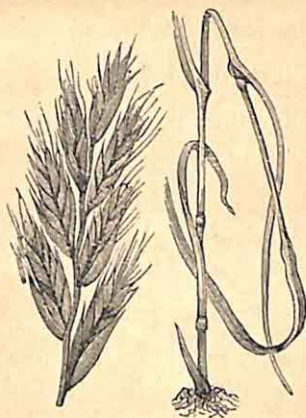


Fig. 103. Plant and part of flower-spike of Rye grass.

3 Now try to find out what kind of inflorescence it is :—

- (a) There are several small bundles of scaly leaves packed close together, on each side of the axis.
- (b) These bundles are sessile on the axis.

Such is called a *spike*—in fact, a compound spike, and each little bundle is a *spikelet*, or little spike.

4. Observe :—

- (a) The spikelets are arranged alternately.
- (b) Each is flattened, and has its narrow edge towards the axis.

#### A SPIKELET.

1. Remove one spikelet ; hold it in the same position as when on the spike. Take off the large outer scale at the base ; it is called a *glume*. Notice :—

- (a) This glume is long.
- (b) It is quite empty.

Many grasses have two empty glumes, one on each side of the spikelet.

2. Then come flowers arranged alternately on either side of the axis of the spikelet. With knife, needle, or pen, remove one of these flowers ; if not open, it is not unlike a small green grain of oats. Open it with the needle ; it consists of :—

- (a) An outer glume (called the flowering glume or *outer pale*).
- (b) A smaller, thinner, and inner scale (called the *inner pale*).
- (c) Within these is the flower.

3. The outer pale or flowering glume is really a bract, in the axil of which the flower grows.

### A FLOWER.

1. It will be better now to find a flower that has opened, and the stamens will be seen hanging out. Observe :—

- (a) The flower has three stamens.
- (b) Each anther is large, and has so thin and slender a stalk, that the anthers hang outside the flower.
- (c) Within is something resembling a small white feather.

2. With knife or needle, remove this feathery body ; it is easily taken out ; observe :

- (a) It has a small globular part.
- (b) On this grow two feathery tufts.

This body is the pistil ; the globular part is the ovary, and the feathery tufts two stigmas.

3. With the aid of a magnifying glass, two small scales may be found within the pales, which held, as in a cup, the ovary just removed. These two, which there may be some difficulty in finding, are the perianth, the pales being bracts, the outer pale or flowering glume that in whose axil the flower is borne.

4. We may then summarize :—

- (a) A spikelet of rye grass consists of one empty glume, and five, seven, or more flowers.
- (b) Each flower has :—
  - An outer and inner pale.
  - A minute perianth.
  - Three stamens.
  - A pistil with two stigmas and syncarpous ovary.

5. In some grasses the perianth is absent ; but the chief features to notice generally are :—

- (a) The number of flowers in the spikelet.

- (b) The number of empty glumes at its base.
- (c) The outer pale (or flowering glume); sometimes it has, as in the present case, a fine point growing from its upper end; this is called an *awn*.

It is the awns of barley, rye, and some grasses that form their *beards*, as they are called.

## LESSON XXXIV.

### POLLINATION, ETC.

*Specimens as in last lesson.*

#### GRASS FLOWERS.

1. By pollination we mean the method by which the pollen is carried to the stigma to secure fertilization. Notice the stamens :—

- (a) The anthers are attached by the middle to the stalks.
- (b) The stalks are slender.
- (c) The anthers thus hang and swing outside the flower.

2. Now, no insect would rub against these in visiting the flower; but there is nothing to induce an insect to visit such a flower; there is no coloured perianth to serve as an attraction; in fact, these flowers are not visited as others are, and there is no need to visit them, for the arrangements of their parts is such that, the pollen is blown from the swinging anthers by the *wind*, caught by the feathery stigmas, and so fertilization is secured.

#### FOREST TREES.

1. Several trees, especially those bearing catkins, oak, beech, hazel, willow, and pine, have their pollen carried by the wind. Thus :—

- (a) Some flowers are insect fertilized,
- (b) Some flowers are wind fertilized.



## NOTES ON A FEW GRASSES.

1. The glumes and pale, when dry, are the chaff of ears of corn.

2. The glumaceous bracts and perianth are a feature of the grasses; bamboo, sugar-cane, maize, rice, wheat, oats, barley, have all this kind of perianth, and generally three stamens and two stigmas. Bamboo, however, has six stamens and three stigmas. These resemblances, together with some pointed out in a former lesson (Part I.), cause these plants to be classified together as grasses.

3. A long and very useful course of lessons might be given on the grasses, not only on account of their interesting characters which require close observation, but on account of their great utility, and the value of a knowledge of them to agriculture. But it is not possible here to go further than point out in conclusion, one or two which may be easily recognised:—

*Timothy grass*, or *cat's tail*, is known by its compact cylindrical spike.

*Fox-tail* is similar, but the spike is silvery-grey and smooth, not rough and green.

*Cock's foot grass* is most easily recognised of all. Its spikelets are all crowded into thick uneven lumpy clusters.

*Dog's tail grass* has a smaller spike, the spikelets clustered, and all turned to one side.

One *oat grass* is known by its drooping spikelets, with two long awns in each.

*Quaking grass* is generally known and gathered as an ornament.

*Agrostis*, or *bent grass*, is described at the head of Lesson XXXIII. As its spikelets are quite unlike those of the rye grass, a brief description of one may be useful.

4. *Spikelet of bent grass*. The inflorescence is a spreading panicle, each spikelet being borne on a short pedicel, and carrying only one flower. Fig. 104 shows a spikelet with the flower open. The two large equal glumes are the empty glumes at the base of the spikelet. There was only one in each spikelet of the rye

grass. Within, to the left, is the outer pale, with a short awn. The inner pale is not shown, being concealed by the feathery stigmas. The perianth is too small to be shown.



Fig. 104. A flower of Fiorin Grass or *Agrostis*.

### EXERCISES.

Various plants should now be examined and scheduled—root, stem, leaves, inflorescence, and flowers. If these lessons have been followed as directed, no other revision is necessary. Dried specimens, if such have been prepared, may be used to a certain extent, in the winter months, and diagrams may now be utilised in summarizing results or making a few broad generalizations.

## LESSON XXXV.

### OUTLINE FOR A SUMMARY OF CHARACTERS.

It will have been noticed in the foregoing lessons, that importance has been attached to the following points, as they have been presented, and in all observations of flowers, special regard should be had to them :—

1. Whether the flower has :—

(a) A double perianth,

(b) A single perianth,

or (c) None.

2. Whether the corolla is

(a) Apopetalous,

or (b) Gamopetalous.

3. Whether the ovary is  
(a) Apocarpous,  
or (b) Syncarpous.
4. Whether the ovary is  
(a) Superior,  
or (b) Inferior.
5. The insertion of the stamens, whether  
(a) Under the ovary,  
(b) Round the ovary,  
(c) Upon the ovary,  
or (d) Upon the corolla.
6. The arrangement of the stamens, whether  
(a) All separate,  
(b) United by stalks (called filaments) in one bundle—monadelphous,  
(c) United by stalks (called filaments) in two bundles—diadelphous,  
(d) United by anthers (filaments separate)—syngenesious,  
(e) In *four and two* arrangement—tetradynamous,  
or (f) In *two and two* arrangement—didynamous.
7. The prevailing numbers of the parts, whether they are  
(a) In twos, fours, and fives,  
or (b) In threes.
- A comparison of such numbers with the leaves and roots of the plants, as far as our lessons have taken us will show:—
- (a) When the prevailing number is three in the flower, the plant has parallel veined leaves, and not a tapering root.
- (b) Where the other numbers prevail in the flower, the plant has net veined leaves, and a tapering root.



## LESSON XXXVI.

## USES OF FLOWERS.

1. *Primary*—i.e., the purpose or function of flowers—the production of seed.

2. *Secondary*—those to which they are put in the service of man.

- (a) Some are used medicinally, as chamomile and marigold.
- (b) Cloves are dried flower buds.
- (c) Cauliflower is the inflorescence of the plant.
- (d) Some produce dyes, as the flowers of the corn marigold, and the petals of dahlia.
- (e) The involucre and receptacles of the artichoke are eaten.
- (f) Many labiate flowers possess an aromatic odour, due to the existence of glands containing oil, which is often extracted, as oil of peppermint, oil of lavender, etc. These oils are called volatile or essential oils. Most of the garden or pot-herbs belong to this class.
- (g) Coltsfoot and cowslip flowers are used in making beer or wine.
- (h) The catkins of the hop are used to give the bitter taste to beer.

But the greatest service which flowers render to us, consists in the pleasure they give to old and young alike, by means of their ever-varied forms and colours. They are, as the poet says, "Stars that in earth's firmament do shine."

## QUESTIONS.

1. What colour have willow flowers?
2. Does this colour serve any purpose? If you do not know, watch some when next they are in bloom.
3. What kinds of insects visit the following flowers: Sweet pea, snapdragon, pansy, wild carrot or hogweed or chervil, and dandelion.

END OF SECTION II.

SECTION III.

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FRUITS & SEEDS.

## NOTE.

To prepare for the work of this section, a collection of dry fruits should be made, if possible in the previous year, as they come in their seasons. They may be looked for as follows :—

*In spring and early summer* : primrose and marsh marigold fruit.

*In summer* : columbine, laburnum, lupin, blue-bell (hyacinth), lily, poppy, red campion, herb Robert and other cranesbills, dandelion, pine cones, violet, pansy, buttercup, and maple.

*In autumn* : pea, vetch, wallflower, snapdragon, foxglove, campion (lychnis), honesty, shepherd's purse, cress, cabbage, herb Bennet, willow herb, cow parsnip (hogweed), fool's parsley, and other umbellates; ash, elm, maple, sycamore, hazel nuts, acorns, chestnuts, horse chestnuts, walnuts, beech masts, burdock, thistle-down, and other pappus-bearing fruits, chiefly composites, such as the hawkweeds and ragworts, teasel, and clematis. Hips, haws, and holly berries may be kept by drying.

Specimens of the above may to great advantage be mounted on small cards, say  $4 \times 3$  ; thus they can be conveniently circulated often round the class.

Some fruits can be bought all the year round ; some berries, such as those of the black bryony, yew, or guelder rose, may be preserved in methylated spirit. This is an easy mode of preserving, but the berries lose their colour.



# OBJECT LESSONS

FROM

Forest, Field, Wayside, and Garden.

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## LESSON I.

### FRUIT AND SEED.

*Fruits of primrose, wallflower, poppy and laburnum, lupin, or other pod.*

#### AFTER THE FLOWER.

1. We have already observed that as a flower withers, one of the organs remains and grows larger. This is the pistil. And we also noticed that before this decay set in, the ovules in the ovary had been fertilized by pollen from stamens in the same or another flower. We shall now try to find out something of the further or later history of the pistil (or fruit as it is now called), as it grows larger and larger, till it reaches its full size.

2. Let us take a primrose or laburnum fruit, and break it open. It contains a number of dry hard bodies, which we at once call seeds. These were once ovules; now if we put them into damp earth, we shall expect to see them spring up into young plants.

#### A COMPARISON.

Let us take specimens of the fruits mentioned at the head of this lesson, and observe:—

- (a) Of the primrose the calyx is persistent round the fruit.
- (b) The style and stigma have disappeared.
- (c) Only the ovary is left, and that is dry and brown.



Fig. 105. Fruit of Primrose contained within the persistent calyx.

- (d) Of the wallflower, the ovary has grown long, and the stigma remains at the top, but the calyx has disappeared.
- (e) Of the laburnum there remains only the ovary, longer, thicker, brown, and dry.
- (f) Of the poppy, the stigma remains on the top of the enlarged ovary.
- (g) When opened, each is seen to contain dry hard seeds, which easily break off from the dried and shrivelled placentas.

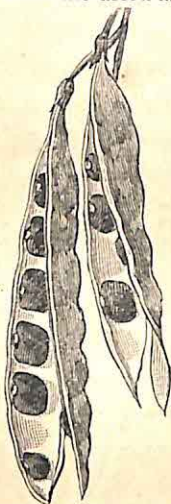


Fig. 106. Fruit (pods or legumes) of Laburnum.

## SUMMARY.

We thus see that :—

- (a) The ovary is the part that has become the fruit.
- (b) The ovules have become seeds.
- (c) Sometimes the stigma is persistent.
- (d) In the primrose the calyx is persistent.

*Note.* If the primrose fruit be quite ripe, we may see that it has opened at the top, or a little pressure will cause it to open, and it will split down the sides into five divisions. Now, when we examined a pistil in the flower, there was nothing to indicate the number of carpels of which it was made up. Here now we have the key to solve the problem. We conclude that the number of carpels, like that of sepals, petals, and stamens, is *five*.

## LESSON II.

### COHESION & ADHESION IN FRUITS.

*Fruits of columbine, marsh marigold, blue-bell (or lily), gooseberry and tomato.*

#### CARPELS—SEPARATE OR UNITED.

1. In former lessons we have seen that pistils are made up of carpels, in some flowers separate, in others grown together. Let us now examine the fruit of the columbine and compare it with that of blue-bell (hyacinth) :—

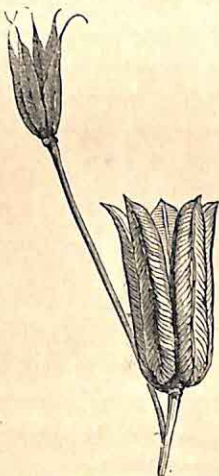


Fig. 107. Fruits of Columbine. Each is a cluster of follicles.



- (a) In the columbine fruit the carpels are separate, just as in the flower.
  - (b) Each carpel can be taken off without injuring the others.
  - (c) The blue-bell fruit is in one piece unless it is very ripe.
  - (d) When cut open it is found to be three-celled.
  - (e) The carpels of this fruit are united.
2. We therefore say of these two fruits :—
- (a) That of the columbine is *apocarpous*.
  - (b) That of the blue-bell is *syncarpous* and three-celled.

3. We may notice further that in the unripe fruits of the columbine something remains of the stigmas, but the ovary part has grown large in the ripe fruit and the stigmas have quite disappeared. When we take off the separate carpels we notice that they burst with a slight pressure (if they have not already done so) and let out the seeds. These carpels remind us of small pea pods, and we may say that the columbine fruit is not unlike a cluster of pea pods growing upright. There is this difference, however, to notice, that while in the pea one flower produces only one pod, in the columbine each flower produces a cluster; in other words, in the pea the fruit consists of one carpel, in the columbine of several. Such separate pods forming parts of one fruit are called little pockets or *follicles*.

4. Examine a fruit of the marsh marigold, and you will find it also *apocarpous* and a cluster of *follicles*.

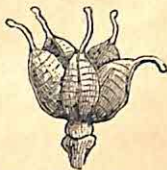


Fig. 108. Fruit of Marsh Marigold (follicles).

## SUPERIOR AND INFERIOR.

1. Take now a gooseberry and a tomato *cut* by the stalk from the plants on which they grew. Observe :—

- (a) The calyx of the tomato is persistent at the base of the fruit.
- (b) Nothing is found at the base of the gooseberry but the stalk; at the top is a small dried brown remnant.

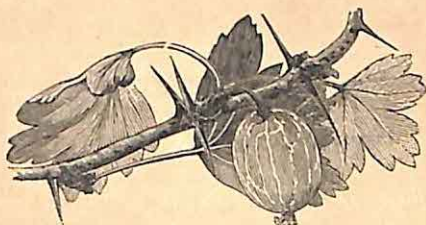


Fig. 109. Gooseberry on stem. The spines are shown in their natural position at the bases of the petioles.

2. This brown remnant is what remains of the calyx. We can at once see the different relation which each of these fruits holds to its calyx; in one case it is free, in the other (the gooseberry) the calyx fringe is at the top; where the base of the calyx is, or where the stalk ends and the calyx begins, we cannot say. It is evident that the calyx has so grown round, and become part of the ovary, that the two cannot now be separated.

3. To distinguish these two fruits in respect to these characters, we use the same terms we should use to describe the ovaries from which they have matured, thus:—

(a) A tomato is a superior fruit

(b) A gooseberry is an inferior fruit.

4. Examine a primrose, columbine and marsh marigold fruit—all are superior. We may also note, as we have done with regard to ovaries in the flower, that though a superior fruit may be apocarpous or syncarpous, an inferior fruit must be syncarpous.

## SUMMARY.

Fruits may be:—

- (a) Superior and  $\left\{ \begin{array}{l} \text{syncarpous, or} \\ \text{apocarpous; or} \end{array} \right.$
- (b) Inferior and syncarpous.

## LESSON III.

## PARTS OF A FRUIT.

*Plums or cherries, acorns, green pea pods.*

**A CHERRY.**

1. Let us examine a cherry. It is a juicy or succulent fruit containing a stone. If we take out the stone and break it we find a kernel or seed within. We thus see that the seed has a three-fold covering :—

- (a) The stone.
- (b) The pulp surrounding the stone.
- (c) The skin surrounding the whole.



Fig. 110. Vertical section of a Cherry to show the three-fold structure of the pericarp and the seed within.

2. In a former lesson we saw that a cherry flower contained a pistil of one carpel, and this one carpel enclosed a single ovule. Here now this single carpel, or rather the lower part of it, has become a cherry; what was only an ovule before fertilization, is now a seed, and that which made up the wall of the carpel has become the three-fold covering we have observed. There were three layers in the ovary, an outer, an inner, and a middle one; the inner one has become hard, the middle one pulpy, and the outer one a thin membrane or skin.



## A GREEN PEA POD.

1. Examine a green pea pod; take out the peas and break or cut the husk. It is easy here to discern a three-fold covering for the seeds:—

- (a) An outer membrane.
- (b) An inner tough, splitting membrane.
- (c) A middle thin layer of solid pulp.

2. Thus we have parts corresponding to those in the cherry, none but the outer one apparently resembling them, nevertheless, three parts arising from a three-fold covering first appearing in the carpel containing the ovules.

3. If an acorn be examined after removal of the cup, similar parts will be found. A cocoa-nut, as we have seen in a previous lesson, has also three coverings to be penetrated before the seed is reached—outer skin, fibre, and stone or shell. We may thus then expect to find a three-fold coating in other fruits, though not always grown or matured into the same form.

## NAMES OF PARTS.

1. Taking that which surrounds the seed as one part of a fruit, the seed being the other, this part is called the *pericarp*. And this pericarp, made up as it is of three layers, is said to consist of:—

- (a) *Epicarp*, the outer layer—in the cherry, the skin.
- (b) *Endocarp*, the inner layer—in the cherry, the stone.
- (c) *Mesocarp*, the middle layer—in the cherry, the pulp.

A plum, peach, almond, or nectarine shows the same parts in the same form.

---

## LESSON IV.

## CHERRIES AND BERRIES.

*Plum, grape, currant, cherry, tomato, date; fruit of primrose, laburnum, or wallflower.*

## TWO KINDS OF PERICARP.

1. If we compare two such fruits as a cherry and that of the primrose, we see at once that whatever other differences there may be between them, their pericarps are very unlike :—

- (a) The pericarp of a cherry is juicy, pulpy, or succulent.
- (b) The pericarp of a primrose fruit is dry and brittle.

2. Thinking of the fruits we have examined up to this point, we should have no difficulty in ranging them either on the side of the cherry or on that of the primrose fruit. Thus we may divide fruits into two classes according to the nature of their pericarps :—

- (a) Succulent fruits.
- (b) Dry fruits.

## KINDS OF SUCCULENT FRUITS.

1. We have already examined the cherry. Such a fruit is called a *drupe*. Other such are, plum, peach, almond.

2. If we now take a grape we find :—

- (a) An outer skin.
- (b) A juicy pulp.
- (c) Seeds within the pulp.

3. We therefore see that of the three parts as found in the cherry (*or drupe*) only one is distinguishable, and that is the outer skin or epicarp. The pulp represents the two inner layers; the seed is not surrounded by a hard covering as in the plum and cherry, but, as a compensation, its own outer skin is hard. Such fruits as these are called *berries*, of which, the gooseberry, currant, tomato, potato apple, and date are examples.

4. An examination of the bramble flower shows us that the pistil is apocarpous, and so we find in the fruit (the blackberry), that the carpels have remained distinct, but each has become succulent. Careful dissection reveals to us the fact that the little hard body within each juicy carpel is not merely a seed as we might be disposed to think it, but a little stone holding the seed like the stone in a cherry. Thus a blackberry consists of a cluster of little drupes or *drupels*, as they are generally called, and is not a *berry* in the sense in which a botanist uses that term.

5. Thus we have two kinds of succulent fruits :—

- (a) Drupes and drupels.
- (b) Berries.

## LESSON V.

### SUCCULENT FRUITS.

(CONTINUED.)

*Any or all of the following:—walnut (green if possible), cocoa-nut with fibre, cucumber, vegetable marrow, orange, lemon, and any berries possible, such as those of the bryony, nightshade, etc.*

#### DEFINITIONS.

1. Let us now try to define a drupe and a berry. First a drupe :—

- (a) It is a succulent fruit.
- (b) Its endocarp or inner coat is hard.
- (c) Its mesocarp or middle coat is a pulp.

So we may say that “a drupe is a fruit which has its inner coat stony and its middle coat succulent.”

A walnut, like an almond, is a drupe. Both, when sold, have generally lost their outer coats, the “shell” being the stone or endocarp containing the seed. Walnuts, as used for pickling, retain the endocarp and mesocarp. A cocoa-nut is also a kind of drupe, but in this case the mesocarp is fibrous and not succulent.



2. In a similar way we may build up a definition of a berry.  
*A berry is a fruit in which both the inner coats are succulent, and the seeds are embedded in the pulp.*

### BERRIES.

1. A few examples of berries which might not at first be thought to be such are:—

*A cucumber*, which has numerous seeds.

*A date*, which contains but one seed.

*An orange or lemon*, which is several-celled, the cell-divisions or walls of the carpels not being succulent.

2. Some berries are *superior* fruits, *e.g.*, orange, lemon, grape; others are *inferior*, *e.g.*, gooseberry, currant, cucumber.

3. Berries are generally a very beautiful fruit, especially on the hedgerows and in the woods in autumn; but, unfortunately, many are poisonous, or at least, injurious. Such are:—the scarlet berries of the twining black bryony; those of the bitter-sweet or woody nightshade; the dark purple berries of the deadly nightshade; the dark berries of the white bryony; and the black berry-like drupe of the buckthorn. As a contrast it may be added that the potato fruit, a marble-shaped dark purple berry, is injurious, while that of the tomato (the love apple) is most wholesome.



Fig. 111. Love Apples or Tomatoes, one in section showing the seeds embedded in the pulp (a berry).

## LESSON V. (A.)

## HOLLY AND MISTLETOE.

## HOLLY.

1. Examine and note the characters of the stem and leaves, the position and colour of the berries.
  - (a) Leaves, tough, glossy, evergreen.
  - (b) The margins of the leaves, spinous.
  - (c) Berries grow in twos and threes in clusters.
  - (d) Each cluster in the axil of a leaf.
2. The bright scarlet colour is very attractive to birds, though the amount of food offered is but small.
3. In this way the seeds are scattered.

## MISTLETOE.

1. Examine and note.
  - (a) The branching is generally into two forks or more.
  - (b) The leaves are small oblanceolate, pale green, and in pairs.
  - (c) They occur at the tips, with buds between them.
  - (d) The berries are round and white, and occur at the bases of the branches bearing the leaves.
  - (e) The pulp is very sticky.
2. The berries were evidently formed before the last season's growth took place.
3. Missel thrushes eat the succulent portions, and to get rid of the seeds wipe their bills on branches of trees or other objects. Thus the seeds get placed in the only positions in which they will grow. For the mistletoe will only grow on another plant. It cannot root in soil. It generally grows on an apple tree.

## LESSON VI.

A MUSTARD SEED AND A GRAIN  
OF WHEAT.

*About a week before taking this lesson, sow on cotton wool over water, or in light damp soil or cocoa-nut fibre, some mustard or radish seed, and grains of wheat. Have at hand for inspection, some unripe mustard or radish and wallflower seeds in the "pod."*

## PARTS OF A SEED.

1. Everyone who knows anything of plants is acquainted with the fact that seeds are formed so that new plants may grow. They are, therefore, the most important part of the fruit. Our attention has up to this point been confined to the pericarp, and it is now time we took some notice of the seeds.

2. Take some not quite ripe wallflower, mustard, or radish seeds. Observe :—

(a) Each seed has a little stalk.

(b) By this stalk it is attached to the pericarp.

3. With the aid of a knife and a needle, carefully cut the outer skin of a seed on one side, and a gentle pressure will bring out a little body with two folded leaves and a little pointed stalk curled up between or against them. This is the little plant, plantlet or *embryo* as it is called.

4. Look now at the growing mustard seeds ; it will be found that, assisted by the moisture, the outer skin has been burst by the embryo which is now growing up as a young plant or *seedling*. The outer skin of the seed is known as the *testa*. We thus see that there are three parts in this seed :—

(a) The embryo.

(b) The testa surrounding the embryo.

(c) The stalk by which the seed is attached to the wall of the cell.



### A GRAIN OF WHEAT.

1. A grain of wheat is not merely a seed, it is the whole fruit, seed and pericarp too, but the latter is so thin and so closely attached to the seed that it looks like the testa of the seed.

2. Take some soaked grains of wheat; a small body is easily removed from the scarred end. This is the embryo. Compare it with the growing or germinating grains. But what is the other part of the grain, the floury part? It is certainly that which is the source of our supply of bread. It is the food on which the embryo would subsist when beginning to grow, until its root was large enough and strong enough to take all that it needed from the soil. This supply or store of food is generally called *albumen*, from its resemblance or analogy to the white of an egg.

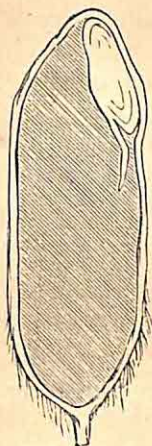


Fig. 112 Grain of Wheat in section, showing embryo and albumen.

3. Observe the leaves on the embryo of the mustard, and compare with those on the growing embryo of the wheat :—

- (a) The embryo of the mustard bears a pair of opposite leaves.
- (b) The wheat embryo has leaves growing singly.

In fact, the former has two leaves, while within the testa, the

latter has only one. It will, probably, be easy to recall instances of seedlings growing up, some with the first leaves as a pair, and different in shape from those that follow after, and others having their leaves placed singly, one only appearing first. Compare in this respect grass and such seedlings as those of sycamores often found growing under or near the parent tree.

### COMPARISON.

(a) The mustard (or radish) seed has no albumen—it is exalbuminous.

(b) The wheat seed has albumen—it is albuminous.

The hollyhock and buttercup furnish two other examples, one of each :—

(c) The mustard or radish embryo has two seed leaves.

(d) The wheat embryo has only one.

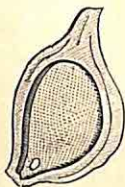


Fig. 113. Vertical section through Fruit of Buttercup, showing pericarp and seed. The latter has its embryo embedded in the albumen.

## LESSON VII.

### SEEDS.

*Some soaked beans and peas, apple pips, acorns ; growing seeds.*

### TWO CLASSES OF PLANTS.

1. In the last lesson we found that the wheat embryo differed from that of the radish or mustard in having one instead of two seed leaves. These first leaves of an embryo are called *cotyledons*.

Now, with a few exceptions (the pines), all our flowering plants have, while in the embryo stage, either one or two cotyledons. A wheat embryo has *never more than one*, a mustard, radish, wallflower, or buttercup, *always two*. And it is further a very striking fact that certain other characters are always associated with the number of cotyledons, *e.g.* :—

- (a) Plants that grow with two cotyledons have generally net-veined leaves, as in the radish and buttercup.
- (b) Plants with one cotyledon, have generally parallel-veined leaves, as in the grasses.

If we examine the flowers of these plants we find :—

- (c) The parts of the flowers of those with two cotyledons are in two's, four's, five's, or ten's, but
- (d) The parts of the flowers of those with one cotyledon are usually in three's.

2. This number of cotyledons therefore appears to be an important character, accompanied as it is by other distinctions, and botanists have agreed to separate flowering plants into two classes on the ground of the number of cotyledons or seed leaves of the embryo. Thus, those plants which have two cotyledons are called *dicotyledons*, and those with one *monocotyledons*.

3. It would be well for the pupil now to observe growing (or *germinating*) seeds, and to decide to which class each one seems to belong, having reference also wherever possible to the character of the leaves of the older plant and numbers of the parts in the flowers.

### A BEAN OR ACORN.

1. Take a soaked bean. Observe :—

- (a) A bean is broad and flat.
- (b) It has a scar on one edge.
- (c) This is where the stalk was attached.

2. Squeeze the bean, and it may be noticed that water comes out at a little hole near the scar. This hole is that through which the pollen grain entered when our seed was only an ovule. The other seeds were too small to show this easily.





Fig. 114. Bean ; part of the testa has been removed to expose the seed lobes (cotyledons) and the root end of the embryo.

3. Now remove the testa and observe :—

- (a) The seed is chiefly composed of two large thick lobes.
- (b) On the edge where the scar was, there is a small pointed body.

Open out the two lobes carefully :—

- (c) The two lobes are attached to the pointed body.
- (d) The upper end of the pointed body curves between the lobes.

4. The two large lobes are the cotyledons of the embryo ; the pointed body is the root end of the embryo, and the curved end that which will grow up into a stem. A bean then is like a mustard seed, but differs in having its cotyledons thick and fleshy. They contain the store of food for the growing plantlet, but as the store is within the embryo and not outside it as in the wheat, a bean is said to be exalbuminous, like the mustard seed.

5. When a bean grows, these two cotyledons seldom rise from the ground, and so are not seen as are those of the mustard, wallflower, and many others.

6. Remove the outer skin (the pericarp) of an acorn and take off the brown covering within (the testa). Squeeze the seed ; it splits into two parts ; there are two fleshy cotyledons like those of the bean ; the root and stem parts are near the apex of the seed. Whenever a seed can thus be easily split into two, it may at once be concluded that the two parts are fleshy cotyledons, and that the seed is exalbuminous. The horse chestnut, so often used by boys in playing a game, is a seed of this kind. The apple pip is another, but its cotyledons rise above the soil when the seed germinates.



Fig. 115. A germinating Acorn; the cotyledons remain within the covering or pericarp.

## SUMMARY.

### 1. We have seen then that:—

- (a) A buttercup seed and a wheat seed are both albuminous.
- (b) A mustard seed and an acorn are exalbuminous.
- (c) Whether albuminous or not the embryos of some plants have always two cotyledons, while those of others have always one.
- (d) Plants are thus divided into two classes, dicotyledons and monocotyledons.

### 2. The characters of these are generally:—

- (a) Dicotyledons—two seed leaves on the embryo, leaves net-veined, parts of flowers in two's, four's, or five's, etc.
- (b) Monocotyledons—one seed leaf on the embryo, leaves parallel-veined, parts of flowers in three's.

## EXERCISE.

*Other seeds should be examined in order to discover whether they are:—*  
 (1) *dicotyledonous or monocotyledonous, (2) albuminous or exalbuminous.*  
*Take, for instance, a plum, an orange, a cocoa-nut (look near one of the*  
*three eyes, the embryo is small and cylindrical), the seeds of any plant that*  
*bears a cruciform flower, a pea, etc. The surface of the testa should also be*  
*noticed; in some seeds it is smooth, in others rough.*

## LESSON VIII.

## THE SCATTERING OF SEEDS.

*Some berries, any pods such as those of laburnum, lupin, or pea; acorns and hazel nuts.*

## RESUME, ETC.

1. We have already seen that:—

- (a) A perfect seed contains an embryo.
- (b) The embryo on germination becomes a plant.
- (c) By seeds plants are reproduced.

2. In an early lesson we saw that:—

- (a) If seeds fall near the parent plant, the seedlings hinder one another's growth, and are overshadowed by it.
- (b) Seedlings grow better when scattered abroad.
- (c) Birds are fond of succulent fruits of all kinds, plums, cherries, and berries generally.
- (d) They generally eat the juicy part, and drop the seed or stone containing the seed.
- (e) Thus birds assist in the scattering of seeds.

3. These conclusions apply chiefly to fruits in their wild state, which are small; and there can be no doubt that the bright colours of such fruits as berries act as guides, and lead the birds to take them. They like their sweet juice, and when the seeds are small, eat up juice and seeds together; but the latter are usually indigestible, and so pass through their bodies uninjured, and without harm to them. Thus the colours as well as the juicy part of the fruit are means which help to bring about what



is best for the reproduction of the plants on which such fruits grow. So, as bees and butterflies are unconscious agents in securing cross-fertilization, birds, equally unconscious, perform a like service in the dispersion of certain seeds.

### DEHISCENCE.

1. So much for succulent fruits, but what of the dry fruits? Let us compare some of these when ripe. Take, for instance, a pea pod or the fruit of a columbine, and a hazel nut. Observe :—

- (a) The pea pod, when ripe, bursts open, and the seeds are jerked out.
- (b) The follicles of the columbine act in a similar way, but the seeds are blown out.
- (c) The nut does not open.

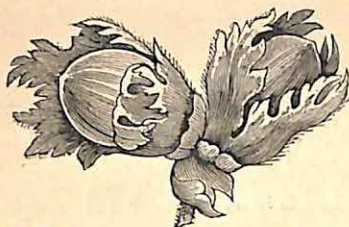


Fig. 116. Hazel nuts, with large bracts (or cupules).

2. We may further compare others, such as are mentioned at the head of this lesson, and so we find :—

- (a) Some dry fruits open when ripe, and eject their seeds, or expose them for ejection.
- (b) Other dry fruits do not open.

3. Now when a fruit opens in this way, it is said to *dehisce* (which is only a Latin word to say the same thing), and the act of opening is called dehiscence. So such fruits as the pea and laburnum pod are called *dehiscent* fruits, while others like the nut are called *indehiscent*.

4. We will leave for after consideration the various modes of dehiscence, how they assist the dispersion of the seeds, and proceed in the next lesson to notice one or two kinds of indehiscent fruits.

## LESSON IX.

## FRUITS THAT DO NOT OPEN.

*Hazel nuts, acorns, and buttercup fruit.*

## NUTS.

1. Look at a hazel nut, observe:—

- (a) A hazel nut is held in a leafy cup of bracts.
- (b) The seed is contained within a hard or stony covering.

The leafy cup is called a *cupule*, it is no essential part of the fruit, *i.e.*, it is no part of the ovary from which the fruit has grown, but a growth of the bracts which surrounded it. The pericarp has become hard. Such a fruit is known as a *nut*—a true nut.

2. Look at an acorn:—

- (a) An acorn rests within a cupule.
- (b) The pericarp is tough and leathery.
- (c) The acorn only differs from the hazel nut in the pericarp being less hard, and the cupule not being leafy.

This fruit is also called a nut.

## BUTTERCUP FRUIT.

1. Let us now look at the fruit of a buttercup. It is composed of a number of small bodies like the carpels which we saw in the flower, only grown a little larger. When ripe, these only fall off, they do not dehisce. The fruit is therefore indehiscent. Cut open one, and find the seed within. Of these bodies, observe:—

- (a) Each is a single carpel, and indehiscent.
- (b) Each differs from a nut, in having no cupule, and in having a pericarp less hard and thinner.

Fruits of this kind are called *achenes*. The fruit of the buttercup is a cluster of achenes.

2. It may be remarked here, but it will also be noticed later, that the ovary of a hazel is syncarpous, being made of two carpels, each having an ovule, but only one ovule is developed into



Fig. 117. Fruit of Buttercup—a cluster of achenes.

a seed; and that the acorn, which has only one seed, is a syncarpous fruit with one cell, but in the flower it was a three-celled ovary, containing two ovules in each cell. The flower also shows us that a nut is inferior. Thus :—

(a) A nut is syncarpous, but an achene apocarpous.

(b) A nut is inferior, but an achene superior.

3. The cupule of the nut must not be mistaken for a calyx; it is an involucre. When the seed (oak, hazel, or buttercup) germinates, it has to grow through the pericarp.

#### SUMMARY AND DEFINITIONS.

1. Fruits may be classified as succulent and dry. Of the latter :—

(a) Some are dehiscent.

(b) Others are indehiscent.

2. A *dehiscent fruit* is one whose pericarp opens when ripe, to let the seeds escape.

An *indehiscent fruit* is one whose pericarp does not open.

3. Of indehiscent fruits we have seen two kinds :—

(a) Nuts.

(b) Achenes.

4. A *nut* is an indehiscent inferior one-celled fruit, having a hard or very tough pericarp, and is usually contained in a cupule.

An *achene* is an indehiscent, superior, one-celled fruit, or portion of a fruit.

Other forms of indehiscent fruits will be dealt with later.



## FRUIT SCHEDULE.

|                        | An acorn.         | Buttercup.                         |
|------------------------|-------------------|------------------------------------|
| Superior or inferior ? | Inferior          | Superior                           |
| Cohesion ?             | Syncarpous        | Apocarpous                         |
| Pericarp ?             | Tough             | Thin and tough                     |
| Epicarp                |                   |                                    |
| Mesocarp               | Not distinct      | Not distinct                       |
| Endocarp               |                   |                                    |
| Cells (or carpels) ?   | One.              | Numerous carpels                   |
| Dehiscence ?           | Indehiscent       | Indehiscent                        |
| Seeds ?                | One, exalbuminous | One in each carpel ;<br>albuminous |
| Kind of fruit ?        | Nut               | A cluster of achenes               |

## LESSON X.

## NUTS.

*Hazel nuts, acorns, beech masts, sweet chestnuts (both the latter as they grow on the tree, if possible); horse-chestnuts, brazil nuts, cocoa nut, and nutmeg.*

## TRUE NUTS.

1. We have seen in the last lesson, that such fruits as the acorn and that of the hazel, are called *nuts*. Let us be quite sure what the characters of a nut are :—

- (a) It is the whole fruit formed from the entire ovary of a flower.
- (b) It is inferior, one-celled, and indehiscent.
- (c) The pericarp is hard or tough.

2. We will now proceed to examine some other “nuts,” and see whether they fulfil the conditions laid down above.

## BEECH MASTS.

1. The beech is a well-known tree. In spring, its leaves are

of a beautiful delicate green, and covered with fine silky hairs, especially along the margins; in summer they are glabrous; in autumn they change to beautiful tints of yellow and orange-red.



Fig. 118. Beech mast, splitting open, showing the nuts within.

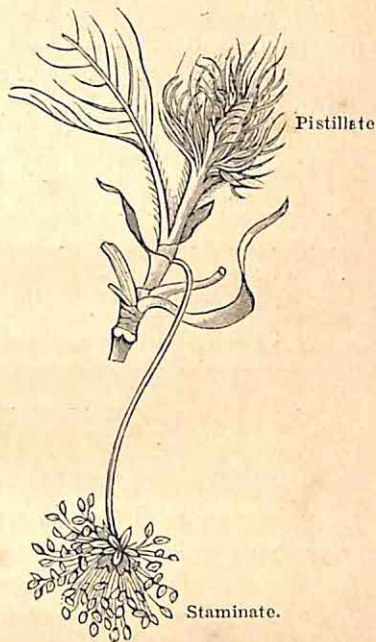


Fig. 119. Flowers of Beech.

2. The fruits called masts can be picked up in quantities under the large trees. Let us examine one of these masts:—

- (a) The outer covering is rough, with rather soft prickles.
- (b) It splits into four parts.
- (c) Within are two (sometimes three) brown tough-coated bodies.
- (d) At the top of each is a little tuft of hairs.

3. To understand the structure of these, we must know something of the flowers, which should be looked for in early spring. Fig. 119 shows what they look like. The staminate flowers are borne at the end of a drooping peduncle, and there are generally twelve of them in each cluster. The pistillate flowers

are in upright clusters of two or three; each cluster is surrounded by an involucre of fine silky hair-like leaves. After fertilization, as the ovaries of these flowers ripen, this involucre grows into a solid mass, covered with prickles, and entirely surrounding the ripening ovaries. Thus we see that the outer covering of the mast is not a part of the ovary, but an involucre, like the cupules of the acorn and hazel nut; the difference lying in this, that it surrounds two (or three) fruits instead of one.

4. We noticed a small tuft of hairs at the top of each of these brown fruits: this tuft consists of the hairy tips of the perianth flower, showing us that the fruit is inferior. Observe one of these brown fruits:—

- (a) It does not split open when ripe.
- (b) It contains a single seed.
- (c) The coating or pericarp is tough.

5. Therefore we have a fruit which is:—

- (a) Inferior.
- (b) Indehiscent and one-celled.

Hence it is a true nut; and the mast consists of two (or three) nuts contained within a cupule, which entirely encloses them until they are ripe. The term *mast* is loosely used for the whole fruit or for the nuts, and is sometimes applied to acorns.

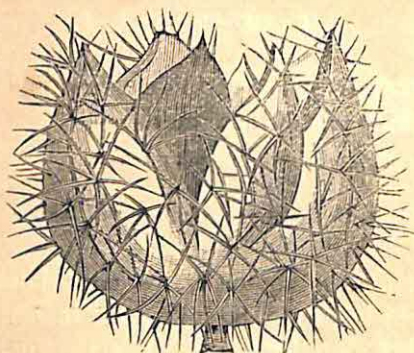


Fig 120. Fruit of Chestnut, consisting of two nuts, contained within an involucre.

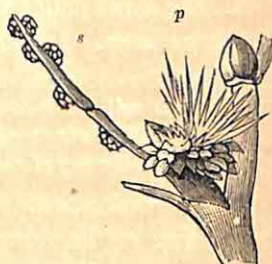


Fig. 121. Flowers of Chestnut.  
s Staminate (not opened).  
p Pistillate.



## SWEET OR SPANISH CHESTNUT.

1. Chestnuts, as sold, resemble beech nuts. If taken from the tree, they are similarly contained within a very prickly involucre or cupule.

2. The chestnut is not a native British tree, but it is now commonly grown, and as in many places its seeds ripen, it is considered as naturalized. Fig. 17 shows a leaf a quarter the natural size. Fig. 121 shows the way in which its flowers grow. When the staminate flowers are open, the inflorescence appears like a long spike, and they are very conspicuous, though apparently consisting of stamens without a coloured perianth.

3. As in the beech, the pistillate flowers are in clusters of two or three together, and the nuts are the ripened ovaries having traces of the perianth at the top. They are inferior, indehiscent, and one-celled, and are consequently *true nuts*.

## OTHER "NUTS."

1. We have already referred to the *cocoa nut*, *almond*, and *walnut*, and seen that in each case the hard covering is the inner part of the pericarp, i.e., the endocarp; consequently these are not true nuts, but the "stones" of drupes or drupe-like fruits.

2. Look now at a HORSE CHESTNUT. The tree bears beautiful cone-shaped clusters of white and pink flowers. The fruit is large, round, and green; it splits open, revealing one, two, or three large mahogany-coloured bodies, each having a large scar at its base.

3. If we follow the growth of this fruit from the flower, we shall see that each is produced from a single flower, but there is no involucre; the green covering is the pericarp, and the so-called nuts are the seeds. Hence a horse-chestnut fruit:—

(a) Is dehiscent.

(b) Has a soft, almost pulpy, pericarp.

(c) Is more than one-celled.

Consequently it is not a true nut, according to our definition, but rather a berry-like fruit, or capsule (see Lesson XIII.).

4. *Brazil-nuts* are seeds that grow within a large fruit, each being covered with a hard stony covering, which is the testa, or outer skin of the seed.

5. *Nutmeg*. The nutmeg, as used in cooking, is a seed which grows

inside the fleshy fruit of an East Indian tree ; it is surrounded by a peculiar growth within the pericarp, known to us as mace. Such growth is called an aril, and appears in certain other fruits, as we shall see later.

6. *Corozo nuts*, used as vegetable ivory, are seeds of a drupe-like fruit of a palm.

7. The *earth nut* is not a fruit at all, but a tuberous root. There are two plants which yield such (also called *pig nuts*).

8. All nuts yield a large proportion of oil.

## SUMMARY.

Thus we have :—

- (a) *True nuts*—acorns, hazel-nuts, beech-masts, and chestnuts.
- (b) *Not true nuts*—cocoa nuts, almonds, walnuts, brazil-nuts, nutmegs, and corozo nuts.

## LESSON XI.

### HOW FRUITS OPEN TO SHED THEIR SEEDS.

*Ripe fruits of lily or blue-bell (hyacinth), violet or pansy, poppy; and columbine.*

#### FRUIT OF POPPY.

1. Examine the ripe fruit of the poppy :—

- (a) The fruit retains the shape of the ovary.
- (b) The large broad stigma is seen at the top.
- (c) Under the edge of this are as many small holes as divisions on the surface of the stigma.
- (d) The seeds can be shaken out through these holes.

2. The holes referred to are called pores, and it is by means of these that the small seeds are shed. The poppy fruit is then *dehiscent*.

#### MODES OF DEHISCENCE—COLUMBINE FRUIT.

1. We have examined the columbine fruit (Fig. 107) and found that it consisted of a number of follicles, each being

matured from a separate carpel. Let us look now how these follicles open or dehisce. Notice first, that as the follicle grows, there are two edges or sides, which we may call the back and the front, the front being towards the centre, the back on the outside of the fruit. Observe :—

- (a) The splitting is down the front edge.
- (b) The seeds are attached to the pericarp along this front edge.



Fig. 122. Ripe fruit of Poppy, showing open pores by which the seeds escape.

2. It will be remembered that we inferred a carpel to be in reality, a folded leaf, the back edge being the midrib, and the front edge the meeting margin to which the ovules (now seeds) are attached.

3. Now, instead of back and front, we shall in future use the terms generally used by botanists, and which mean the same, viz., *dorsal* for back and *ventral* for front.

4. Compare the splitting in a pea pod and notice :—

- (a) The dehiscence in a columbine follicle is down the ventral side.
- (b) In the pea pod the dehiscence is both ventral and dorsal.

## FRUITS OF PANSY AND LILY.

1. Let us examine a pansy or violet fruit. We have already noticed :—

- (a) The pansy ovary is syncarpous.
- (b) It is made up of three carpels.

2. This we shall have further evidence of in the fruit. But, we must first consider that as three carpels are joined together,



by which edge they will be attached to one another, the dorsal or ventral; undoubtedly by the latter.



Fig. 123. Two fruits of Violet. The lower one is open to show the attachment of the seeds along the ventral suture.

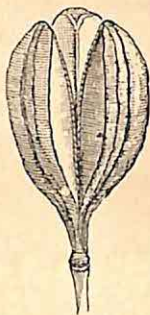


Fig. 124. Fruit of Lily split down the dorsal suture into three valves—the seeds are not shown.

3. Now take an opened pansy fruit and clear away most of the seeds as in (Fig. 123). Observe:—

- (a) The fruit splits into three parts (called valves).
- (b) The seeds are attached along a line down the middle of each of these valves.
- (c) This line of attachment must be the ventral edge of the carpels.
- (d) Therefore the dehiscence is down the dorsal edge.

4. Examine the fruit of a lily (Fig. 124), or a blue-bell (wild hyacinth). This fruit is three-celled. Notice:—

- (a) The fruit splits into three valves.
- (b) The seeds are attached to the middle of the valves.
- (c) The dehiscence is, therefore, again dorsal.

5. These slits from top to bottom are called *sutures*, so we say that the dehiscence in the above instances is *valvular* and along the *dorsal suture*.

6. It is easy to see then, that if in a syncarpous fruit the dehiscence were to take place along the ventral suture, the cells or carpels would be separated from one another, and would not necessarily be opened thereby to shed the seed. Some such instances will be dealt with in another lesson.

## SUMMARY.

## 1. Dehiscence may take place:—

- (a) By pores.
- (b) By sutures—either dorsal or ventral, or both.
- (c) If syncarpous, in order to shed their seeds, the fruits may be split into valves down the dorsal suture.

## • LESSON XII.

## SOME FRUITS THAT OPEN.

*Fruits of shepherd's purse, wallflower, cabbage, honesty; columbine and pea, broom or laburnum.*

## SHEPHERD'S PURSE.

1. This plant, as we have already seen, is a very common weed, having small purse-like fruits preceded by very small flowers which, in structure, resemble those of the wallflower-cuckoo flower, and cabbage.

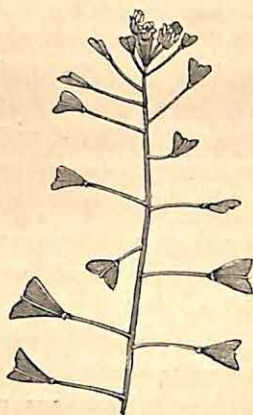


Fig. 125. Portion of inflorescence of Shepherd's Purse, bearing flowers and fruit.

## 2. Take some of the riper fruits. Observe :—

- (a) The fruits easily split from the base upwards.
- (b) Two parts become detached.
- (c) A central upright partition remains and to it the seeds are attached.

3. Take the fruit of a wallflower, and though much different in shape, it will be found to dehisce in the same way.



Fig. 126. Fruit of Shepherd's Purse—  
a silicle.



Fig. 127. Fruit of Wallflower—  
silique.

## 4. We thus observe in these two cases :—

- (a) The fruits are two-celled (formed of two carpels).
- (b) The dehiscence is ventral.

The central partition which remains is not a part of the carpels, but an upward growth from the stalk; the seeds remain attached to it. If it were not for this the fruit would be one-celled, the placentation *walled* as in the fruit of the pansy.

5. Such a fruit as that of the wallflower is called a *siliqua*, that of the shepherd's purse a *silicle*, the difference being in the length compared with the breadth.



## COMPARISON AND DEFINITIONS.

1. You may have seen growing a plant called honesty, or have seen large round shining disks, which are sometimes preserved as ornaments. These are the central partitions of the fruit of this plant. The structure and dehiscence is exactly similar to the wallflower and shepherd's purse fruit, the shape only is different. As the length is no greater, or very little greater than the breadth, this fruit is also called a silicle. It should be noticed that it is compressed, so that the partition is across the broader diameter, and not across the narrower one as in shepherd's purse.

2. Compare the cabbage, mustard, or cuckoo flower fruit. They all resemble that of the wallflower, while the fruit of the garden cress is short and broad. The first three are siliques, the last is a silicle.

3. Let us now try to define these fruits.

Of a silique we see :—

- (a) It is dehiscent.
- (b) It has two carpels.
- (c) The carpels separate from the base upwards.
- (d) A partition is left to which the seeds are attached.

Therefore *a silique is a dehiscent fruit of two carpels which separate from the base upwards, leaving the seeds attached to an erect partition.*

*When the breadth is nearly equal to the length the fruit is called a silicle.*

All these fruits are borne on plants which have cruciform flowers.

## PEA AND COLUMBINE.

1. These fruits we have already examined ; it remains only to say that a pea or other such pod is often called a *legume* ; hence plants with such fruits are said to be leguminous.

2. Observing the characters of these fruits we may build up definitions ;—*A legume or pod is a fruit consisting of one carpel*

which opens along both the dorsal and ventral sutures, e.g., pea, laburnum, lupin, gorse, broom.

A follicle is a single carpel which opens along the ventral suture. More than one follicle results from a single flower.

3. We may classify these fruits as follows :—

- (a) Dehiscent fruits formed from one carpel—legume and follicle.
- (b) Dehiscent fruits formed from two carpels—silique and silicle.

## LESSON XIII.

### SOME FRUITS THAT OPEN.

(CONTINUED.)

*Fruits of poppy, campion, pink or sweet william, snapdragon, pimpernel, primrose.*

#### SNAPDRAGON.

Examine a ripe and an unripe fruit. Observe :—

- (a) The fruit is two-celled and the seeds numerous.
- (b) The dehiscence is by pores.
- (c) The seeds are attached to an axile placenta.
- (d) It resembles the silique in the number of carpels and cells.
- (e) It differs in its mode of dehiscence and the placentation.

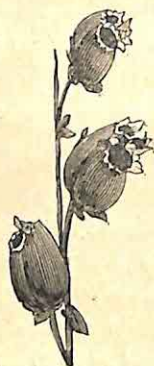


Fig. 128. Capsules of Snapdragon.

**CAMPION.**

1. This is a name given somewhat loosely to two or three kinds of *lychnis* and *silene*; the former has five styles on the ovary, the latter three. In the fruit the styles have disappeared.

2. Examine the fruit of the red *lychnis* (or *campion*) Fig. 129 :—

- (a) The calyx is persistent round the fruit.
- (b) The dehiscence consists of a small opening at the top.
- (c) Ten sharp-pointed teeth turn downwards, and so form a small round opening.
- (d) The fruit is one-celled.



Fig. 129. Capsule of Red *Lychnis* (*campion*).

3. As we see five styles in the flower we conclude that the ovary is made up of five carpels, and, consequently, we are able to understand the meaning of these ten teeth. The dehiscence is both dorsal and ventral for a short distance; so there are twice as many teeth as carpels.

4. If we look at a fruit of a *silene* which has three styles, we find the number of teeth is six. Examine in the light of these facts the fruits of pinks and sweet williams.

5. Such fruits as these are called *capsules*, from a word meaning a little case or pocket. The fruits of the poppy, pansy, lily, snapdragon, foxglove, primrose, and *campion* are all capsules.

6. If we notice and write down what characters all these have in common we shall be able to define a capsule :—

- (a) They are all dehiscent.
- (b) They each consist of two or more carpels.
- (c) They are one or more celled.
- (d) They may open by valves, teeth, or pores.



Therefore a capsule is a dehiscent fruit of two or more carpels opening by valves, teeth, or pores.

This definition does not exclude the silique and silicle which are sometimes regarded as special forms of capsules.

### THE SCARLET PIMPERNEL.

1. We have not examined this plant at all yet. It might, when growing, be taken at a rough glance for a chickweed, but its habit is different, and its flowers are always scarlet or purple, never white. Its flower is affected by the state of the atmosphere, for it never opens if it is damp; hence it has been called the "shepherd's weather-glass."

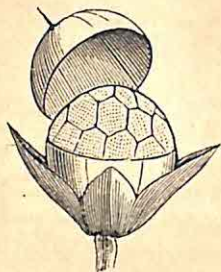


Fig. 130. Capsule (pyxis) of Scarlet Pimpernel.

2. Its fruit is small and globular, and opens as shown in Fig. 130. It is also a form of capsule (sometimes called a pyxis).

3. Neither dehiscence nor style gives any indication of the number of carpels; but, as all its parts are in five's, that number is inferred to represent them.

### SUMMARY.

Of dehiscent fruits we have:—

- (a) Those of one carpel—follicle and legume.
- (b) Those of two carpels—silique and silicle.
- (c) Those of two or more carpels (not including the above)—capsule.

### EXERCISE.

Fill in schedule as given for any of the above fruits, adding "mode of dehiscence."

## LESSON XIV.

## CRANE'S-BILL.

*Fruits of meadow crane's-bill, herb Robert or dove's-foot geranium. Plants in flower also if possible.*

## CRANE'S-BILL IN FLOWER.

1. There are several plants that bear this name, which they derive from the character of their fruit. They are also known by the name *geranium*, a word meaning *a crane*. The so-called cultivated geraniums are pelargoniums, originally brought from South Africa. The crane's-bills most easily recognised are :—

**Herb Robert**, a plant with red knotted stems, compound twice ternate leaves, which turn red late in the summer, and always give off a very strong disagreeable smell, especially when rubbed ; the flowers are small and of a pale pinkish purple.

**Shining Crane's-bill** is a scarcer plant with small flowers, and small round five-lobed leaves also turning red.

**Meadow Crane's-bill** ; this and two other kinds have large handsome purple flowers and palmatisect leaves. There are several smaller kinds, but all have such a fruit as is shown in Fig. 131.

2. If the flower be examined the following characters should be observed :—

- (a) Calyx gamosepalous of five sepals.
- (b) Corolla apopetalous of five petals.
- (c) Stamens ten, and pistil of five carpels, syncarpous.



Fig. 131. Fruit of a Crane's-bill.

## THE FRUIT STRUCTURE.

1. As the fruit develops the stigmas seem to be pushed up at the end of a growing axis until the long bill of the fruit is formed. Observe:—

- (a) A crane's-bill fruit has a long central axis.
- (b) Round this axis are five seed-like bodies.

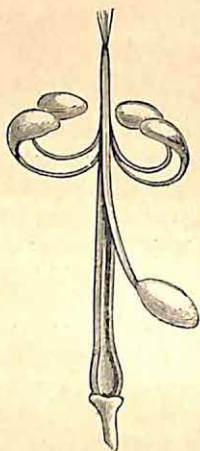


Fig. 132. Fruit of a Crane's-bill, separating into five parts.

2. It is well to be careful not to call them seeds, for if examined in the flower it will be found that these constitute the ovary and are united.

3. If now some quite ripe specimens are taken, the following observations may be made:—

- (a) The dehiscence of the fruit takes place *between* the seed-like bodies.
  - (b) These are each attached to the central axis.
  - (c) As they separate from one another, the thin membrane by which they are attached curls up. (Fig. 132.)
  - (d) The curling up of the membrane is sometimes so violent that the knobs are jerked off to some distance.
  - (e) In other cases the knobs are left on, as in Fig. 132, but split open and empty.
4. Examine one of these knobs before its opening :
- (a) Each contains one seed.



## CONCLUSIONS.

1. We thus see that in some cases the seeds are scattered without the splitting of the fruit.

2. The beak is a kind of axis round which the carpels grow.

3. The attachments act as a means of scattering the seed. If some nearly ripe fruit is kept in a room, the ejection may be observed.

4. Such fruits are not entirely of the opening or dehiscent class, but rather of the kind called *splitting* or *separating*.

Stork's-bill. The fruit of this plant closely resembles that of the crane's-bill, but the bill is spirally twisted. When thrown off, the parts of the fruit have, by the aid of the detached portion of the bill and certain bristle-like growths, the power of motion, according to the dampness of the atmosphere. This motion tends to fix them in the ground and prevent their removal.

## LESSON XV.

## HOGWEED.

*Specimens of fruit, and plant in flower (if possible), parsnip "seeds" from the seedsman's. Instead, fool's parsley or any umbelliferous plant.*

## THE PLANT AND ITS FLOWER.

1. The hogweed or cow parsnip is a very common plant often gathered by boys as food for rabbits:—

- (a) It is tall and roughly hairy.
- (b) The stem is hollow.
- (c) The leaves are large-lobed and roughly pinnate or ternate.

2. The inflorescence is also characteristic, being a compound umbel; the characters of the flower are:—

- (a) No visible calyx except the covering of the ovary.
- (b) Petals five, apopetalous, and growing on the ovary, or edge of calyx.
- (c) Stamens five, and on the ovary, or edge of calyx.
- (d) Pistil of two carpels, ovary inferior, syncarpous.

## THE FRUIT.



Fig. 133. Fruit of Hogweed ( $3\frac{1}{2}$  times nat. size).

1. If the flower is characteristic, still more so is the fruit:—

- (a) It is flat and obovate.
- (b) Remains of the two stigmas still appear at the top.
- (c) It is winged on the edges.
- (d) When ripe it splits into two parts through its broadest diameter.

- (e) Each half remains attached for a while by a fine thread to a slender central axis.
- (f) These two parts are not ejected like those of the crane's-bill, but drop or are brushed off.
- (g) There is one large seed in each *half fruit*.

2. Thus we see :—

- (a) This fruit resembles that of the crane's-bill in separating into parts corresponding to the carpels of which it is made up.
- (b) The splitting also is between the cells, ventral not dorsal.
- (c) The seeds are not let out.
- (d) The fruit is one splitting into two parts, *i.e.*, a splitting fruit like that of the crane's-bill.

## OIL.

1. Certain dark lines may be observed down the outsides of the fruits running between ribs. Cut across a fruit not quite ripe; the ribs will be seen in transverse section, and between them these darker lines also in cross section.



Fig. 134. Slice out of the middle of a half-fruit of Hogweed, showing vittas and seed with embryo.

2. These are oil glands, and are generally known as *vittas*, they contain an oil which gives an odour to the plant. Several other plants, with similar fruits, have oil glands. The so-called caraway *seeds* are the half-fruits of such a plant, and the pleasant pungent odour and taste of them are due to an oil similarly contained. Oils like these, which can be distilled without decomposition, are called *essential* or *volatile* oils. Sweet cicely and goutweed derive their pleasant odours from the existence of such oils in the vittas of their fruits as well as in glands of their stems. On the other hand, many oils like those obtained from nuts and seeds, exist in the cells mingled with starch and other contents, and are of a less volatile nature. They have little or no odour, and are called *fixed oils*.



**SEEDS.**

If one of the half fruits be cut through (for the pericarp adheres to the seed) in slices, a small embryo will be found embedded in the albumen. Careful dissection is necessary, and an unpractised hand and eye may not discover it.

**UMBELLIFEROUS PLANTS.**

1. There are many plants whose flowers are borne in compound umbels, like the hogweed. They differ little in their flowers, but their fruits, although alike in structure, present many varieties of forms. Some are flattened so as to split across the shorter diameter, some are almost globular, and some much elongated, as in caraway "seeds" and sweet cicely.

2. The ribs on the fruit should be observed; they are the midribs and marginal joinings of the sepals, which form the adherent calyx. There are five on each half-fruit (or mericarp, as it is called). Each midrib or dorsal suture, is opposite a petal in the flower.

**EXERCISE.**

*Fill up schedules of fruits. Three specimens are given on the next page.*

## EXERCISE.

## FRUIT SCHEDULE.

|                                              | Campion.        | Crane's-bill.            | Hogweed.               |
|----------------------------------------------|-----------------|--------------------------|------------------------|
| Superior or inferior?                        | Superior        | Superior                 | Inferior               |
| Cohesion?                                    | Syncarpous      | Syncarpous               | Syncarpous             |
| Pericarp?<br>Epicarp<br>Mesocarp<br>Endocarp | Dry             | Dry                      | Dry, with vittas       |
| Cells (or carpels)?                          | Not distinct    | Not distinct             | Not distinct           |
| Dehiscence? Kind?                            | One-celled      | Five-celled              | Two-celled             |
| Seeds                                        | By ten teeth    | Into five parts of fruit | Into half-fruits       |
| Kind of fruit?                               | Small, numerous | One in each cell         | Two, large, albuminous |
|                                              | Capsule         | Splitting fruit          | Splitting fruit        |

## LESSON XVI.

## WINGED AND PLUMED FRUITS.

*Fruits of:—(1) ash, maple, sycamore, or elm; (2) dandelion "clocks," or those of similar plants; (3) clematis, if possible.*

## FRUIT OF MAPLE.

1. We will take the fruit of the maple as a type, though perhaps the fruit or "bunches of keys" of the sycamore and ash are better known. However, what is said of the maple will generally apply to the sycamore.

2. The maple is not so tall a tree as the others, and it often only attains the height of a shrub. It may be easily recognised by the shape of its leaves, and their deep red colour in early spring. (Fig. 135.)

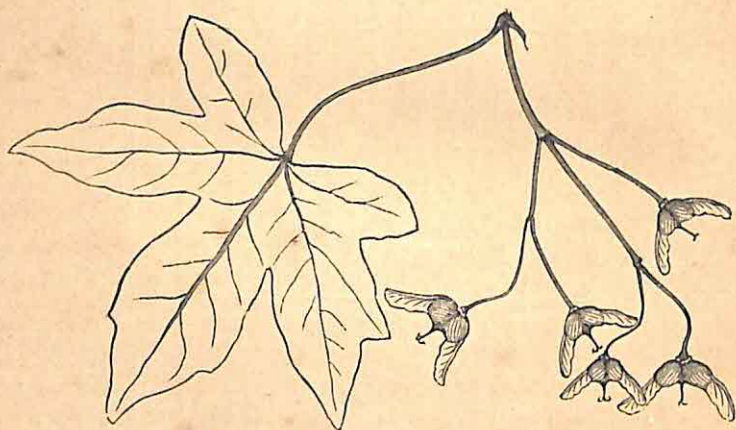


Fig. 135. Half-ripened fruits of Maple.

Like the sycamore it flowers immediately after the opening of the buds in spring, bearing tassels or drooping racemes of green flowers.

3. Examine the fruit:—



- (x) Each fruit has a hard part in the middle, and on each side a thin spreading piece of membrane.
- (b) The style with two stigmas persists.
- (c) A little pressure causes the fruit to split into two parts when ripe.

4. If left, the fruits split without pressure, and each part has one piece of thin membrane, which we may call a "*wing*," for there is no doubt that it helps the half fruit to be carried by the wind more easily. We must notice, too, that the fruit does not let out its seeds. The dehiscence is along the ventral suture:—

- (a) The fruit is syncarpous of two carpels.
- (b) It splits into halves; each half is furnished with a wing.
- (c) Each half fruit contains one seed.

Such winged fruits which do not let out their seeds, are called *samaras*.

"CLOCKS."

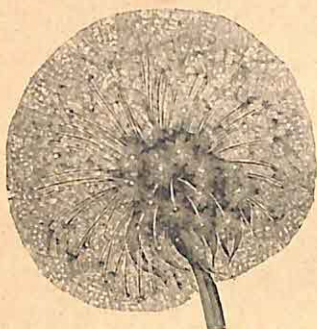


Fig. 136. "Clock," or head of fruits of Dandelion.

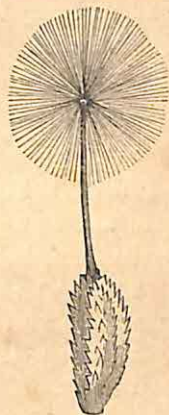


Fig. 137. Single fruit of Dandelion.

1. Most children know the clock as shown in Fig. 136. When a dandelion goes out of flower, the involucre closes round the head, which hangs down until the fruit is ripe. The stalk then lifts up, the involucre opens out, and the clock appears, to the joy of many a little one, who believes he is able, by blowing off the light feathery bodies, to tell the time of day.

2. Take some of these bodies singly, and observe:—

- (a) Each grows in place of a flower.
- (b) Each consists of three parts—the ovary, now hard and ripe; a long thin stalk, a plume of down at the top.
- (c) The down is what we saw in the flower, as the calyx or pappus.
- (d) Each fruit contains one seed.
- (e) The fruits do not split open—they are indehiscent.

3. We have before had a fruit, or part of a fruit, with tough covering, indehiscent, and holding a single seed. Such we saw in the buttercup, and called it an *achene*. This is a kind of achene, but not a true one, for it will be remembered:—

- (a) The achene of a buttercup grows from one carpel.
- (b) The fruit of the dandelion grows from two carpels.

4. But a more important point to notice is, the use of the pappus or plume, at the top of the fruit. The blowing at once shows us how easily the fruit can be carried far away, and scattered by the wind. As the dandelion is such a low growing plant, it would be most unfavourable to its increase for its seeds to fall round the parent plant. As it is, we are never surprised to see dandelions growing anywhere and everywhere.

#### OTHER PLUMED FRUITS.

1. There are many plants whose fruits bear a pappus, like those of the dandelion, the common groundsel, ragworts, and thistles. Those who have seen thistle down blown by the wind, like a snowstorm, will have no doubt as to the part it plays.

2. If you take a thistle head, in which the fruit is nearly ripe, put it into a glass jar, and keep it in a dry place, you will soon find the jar full of down; the expanding plumes having pushed each other out of place.

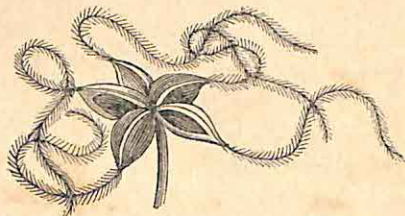


Fig. 138. Fruit of Clematis or "Old Man's Beard."

3. The fruit of the wild or English clematis (old man's beard) is similar, but there are these differences :—

- (a) The fruit is of five separate carpels.
- (b) Each carpel is indehiscent, and a true achene.
- (c) Each achene has a long twisting plume.

### SUMMARY.

1. Samaras are winged fruits.
2. Many fruits are crowned with a plume of hairs or down.
3. Both wings and plumes aid in the scattering of seeds.

## LESSON XVII.

### HIPS, HAWS, AND APPLES.

*Ripe fruit of rose, hawthorn, mountain ash; apple and pear.*

#### HIPS OF ROSE.

1. We have observed the flowers, and seen the peculiar form of the ovary. Let us proceed at once to examine these bright red fruits :—

- (a) The fruit of the rose is like a berry in appearance.
- (b) At the top the sepals remain as in an inferior fruit.
- (c) When cut open, the hip is seen to be full of seed-like bodies.
- (d) These seed-like bodies are not attached to the sides of the fruit, or to a placenta of any kind.
- (e) Each has its pointed end directed upwards, and there is a string-like connection with the bottom of the cup.



Fig. 139. Hip of Rose cut open to show the achenes within.



2. We must now recall what we saw in the flower. There we found in the ovary seed-like bodies, each bearing a style; the tops or stigmas protruded at the mouth of a hollow cup or top of the flower-stalk, round which mouth were inserted the petals and stamens. We therefore concluded that these separate seed-like bodies were carpels sunk in the hollow top of the stalk, instead of being carried on a raised platform. Accordingly we must now see that we have a fruit made up of a number of separate carpels and surrounded by a covering specially formed from the hollow stalk or receptacle.

3. Further examination shows:—

- (a) Each carpel holds one seed.
- (b) The pericarp is hard and indehiscent.
- (c) The fruit is therefore a cluster of *achenes*, surrounded by a fleshy growth of the stalk.
- (d) Each achene is covered with loose hairs, which easily rub off.

### THE FLESHY COVERING.

A little thought will lead us to see the use of the fleshy covering, and the hairs on the achenes. It is well known that birds are fond of hips, and their bright colour must be a means of attraction to them. But however pleasant this juicy covering may be to the palate of a bird, it can scarcely be expected that the hairs on the achenes would be otherwise than very distasteful; so, it may be surmised, a bird relishes the red outer part, but rejects the hairy achenes, thus bringing about the scattering of the seeds.

### APPLES.

1. Cut an apple horizontally through the middle (Fig. 140). Observe:—

- (a) There are five separate cells.
- (b) Each contains seeds.
- (c) The space between is filled up with a hard pulp.

2. To explain this, we must go back to the flower. It is constructed on exactly the same plan as that of the rose. It has

five carpels sunk within the hollow top of the stalk, and these five carpels have become the five separate cells. The pulp is thus a thickening of the sides of this hollow cup, just as we have seen it in the rose, only in this case, to a greater extent. The uncultivated apple or crab has only a small quantity of surrounding pulp.

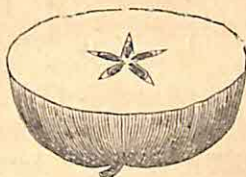


Fig. 140. Transverse section through middle of an apple.

3. We may conclude :—

- (a) The true fruit of the apple is the five cells.
- (b) The scaly cell walls are the pericarp.
- (c) This fruit is apocarpous, but appears syncarpous by the growth of the pulp from the walls of the hollow top of the stalk.
- (d) Such a fruit (true fruit and surrounding pulp) is called a *pome*.

4. The pear is similarly a pome. Examine the fruit of the hawthorn (or mountain ash) ; it is like both apple and hip :—

- (a) It resembles the apple, in having a pulp (a mealy one).
- (b) It resembles the rose hip, in having achenes.
- (c) All furnish food to those who are thereby induced to scatter their seeds.

## LESSON XVIII.

## SOME OTHER "BERRIES."

*Strawberries, figs, esp. green, yew berries; if these last cannot be had fresh, some should be ready in spirit.*

## THE STRAWBERRY.

1. Recall the definition of a berry. It has been shown that blackberries and raspberries do not satisfy this definition, and we have also seen that a strawberry does not. Observe:—

(a) A strawberry consists of a pulp covered with seed-like bodies.

(b) Each of these small bodies has grown from a single carpel.

2. Compare with fruit of buttercup, silverweed, or cinquefoil, which is, in each case, a cluster of achenes borne on an enlarged end of the flower-stalk. If we imagine this enlarged end to grow until it is as big as a marble, we shall see that the achenes would be pushed out on the surface of it. This is what really happens in the strawberry; the enlarged end becomes succulent and sweet, bearing achenes on its surface.

## THE FIG.

1. A fig does not seem at first unlike a berry; not that it is ever so called, for it usually has no other name applied to it than that of fig; yet it in no wise corresponds to a berry except in being pulpy.

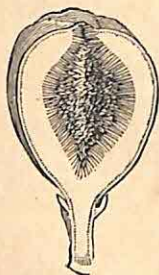


Fig. 141. Vertical section through the middle of a Fig.



Fig. 142. Two flowers of the Fig, the upper one staminate, the lower, pistillate.



2. If cut open, a fig is found to consist of:—

- (a) An outer covering.
- (b) A mass of pulp.
- (c) Small round bodies embedded in the pulp.

3. Now, in the first place, a fig is not, like other fruits we have observed, formed from a single flower. If possible, one should be obtained young and green. It will then be seen that the young fig consists of a hollow cup or receptacle, on the inside of which numerous small flowers are clustered together, like those shown in Fig. 142. Most of them are pistillate only, a few being merely staminate. After fertilization has taken place and the little fruits begin to develop from the ovaries of the pistillate flowers, the mouth of the hollow cup closes, its walls become pulpy, and the fig ripens. We thus see:—

- (a) The seed like bodies in a fig are fruits.
- (b) The whole fig is a fleshy hollow receptacle, containing numerous fruits.

4. We may compare a fig with the hip of a rose:—

- (a) In both we have a hollow top of the stalk or receptacle, which becomes fleshy or succulent.
- (b) The rose hip contains several achenes, which have grown from an apocarpous ovary of a single flower.
- (c) The fig contains several whole fruits, each developed from a separate flower.

If then we call the whole fig a fruit, we must speak of it as one derived from a collection of flowers.

### THE YEWE "BERRY."

1. Here again, we have something peculiar. Look at a ripe yew "berry":—

- (a) The outer part consists of a red succulent cup.
- (b) Within the cup is a hard seed or stone.

2. If some young berries are obtained, no outer covering will be seen; there will only be the hard stony part. See Fig. 143.

3. The ovule of the yew flower is not borne in a carpel at all, but without covering, so the seed is quite naked. As it ripens,

however, a growth of tissue is formed round it from its base, and this becomes the juicy red outer part. Such a covering is called an *aril*; there is a similar one surrounding the nutmeg; it is used as a spice, and called mace.

4. The seed of the yew is poisonous.



Fig. 143. Fruit of Yew; (a) in an early stage, seed almost quite naked; (b) ripe, and covered with an aril.

## LESSON XIX.

### COLLECTIVE FRUITS.

*Pine cones, pine apple, drawing of mulberry.*

#### PINE CONES.

1. These are the fruits of the pine. When fully ripe, the hard scales open, and let out the seeds. Notice:—

- (a) A pine cone consists of numerous overlapping hard woody scales.
- (b) On the upper side of each scale are two seeds.
- (c) Each seed has a thin membranous wing.
- (d) The seeds are not enclosed in any covering, but are naked, like those of the yew.

2. The lightness with which the seeds float in the air, leaves no doubt as to the purpose of the wings.

3. Pine flowers are very simple. The pistillate flowers consist simply of a couple of ovules on the upper side of a scale, which is either a bract or an open carpel. The staminate flowers also grow in cones; each cone consists of numerous short catkins

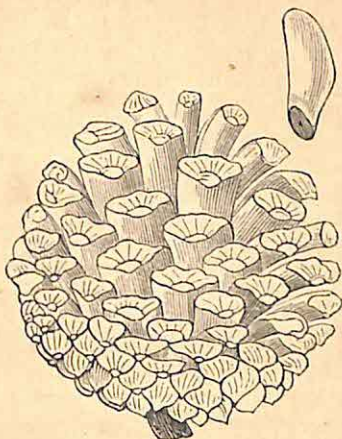


Fig. 144. Cone of Scotch Pine, opening to let out seeds;  
and one winged seed.

of minute flowers, and each flower is simply a scale with two stamens on its under side. The pollen is produced in great quantities, for as the pollination depends upon the wind, much is sure to be lost, and never reach its destination. If you shake a pine tree when these staminate cones are ripe, you will soon be covered with the yellow pollen.

4. When the pollination is effected, and a pollen grain is so placed that it can fertilize an ovule, it takes a year for it to accomplish that object; and it is not until the third summer that the cone is ripe.

5. As for the cone, we see:—

- (a) It is a fruit produced from a collection of flowers.
- (b) The seeds are naked and winged
- (c) The wings assist in the scattering of the seeds.

## PINE APPLES OR ANANAS.

1. Pine apples are not fruits of any pine. They grow on a small plant which is a native of South America. It will be observed that the fruit is large and juicy, has often no seeds, and bears a tuft of leaves at the top.



2. Grown in its native country in a wild state, seeds are formed; it is only under cultivation, when it would appear that fertilization is not accomplished, that no seeds are developed from the ovules.

3. Numerous flowers grow on the central stalk or axis, below the top tuft of leaves; from each of these flowers a berry is formed; the calyx or perianth adheres to it, and also becomes succulent; and all the berries and perianths on one stem (or the whole inflorescence) grow into one mass, which we know as a pine apple.

Thus we see :—

- (a) A pine apple is a fruit growing from a collection of flowers.
- (b) The perianth of each flower, as well as the ovary, becomes succulent, and all unite into one mass.
- (c) The whole fruit is not an apple, and it does not grow on a pine.

## A MULBERRY.

1. The mulberry, which is a less familiar fruit, is not unlike a pine apple in its structure. The pistillate flowers grow in a cluster, each surrounded by its perianth, and on the fruit ripening, both the pericarp of each ovary, and the surrounding perianth become succulent. These succulent bodies are then so close together that they resemble a blackberry.

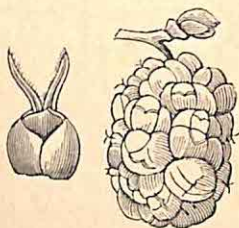


Fig. 145. Pistillate flower and ripe fruit of Mulberry.

2. Observe :—

- (a) A blackberry is a fruit derived from one flower.
- (b) A mulberry is a fruit derived from a collection of flowers.
- (c) Neither is a berry, according to our definition.

## SUMMARY.

1. Fruits may be divided into two classes :—
  - (a) Those developed from a single flower—*simple fruits*.
  - (b) Those developed from a cluster of flowers—*collective fruits*.
2. Examples :—
  - (a) Simple fruits—grape, blackberry, strawberry, cherry, etc.
  - (b) Collective fruits—fig, pine cone, pine apple, mulberry.

## LESSON XX.

## DISPERSION OF SEEDS.

*Fruits of burdock, willow herb, violet or pansy, herb Bennet, hound's tongue, cotton-sedge.*

## HOOKED FRUITS.

1. It will now be interesting to make a summary of the various plans by which the scattering or dispersion of seeds is brought about. Before doing so, let us make one or two additions.



Fig. 146. Fruit of herb Bennet (*Geum* or *Avena*), consisting of hooked achenes.



Fig. 147. Hooked involucre of Burdock, enclosing fruit.

2. Let us take first the herb Bennet. The flower is yellow, and not unlike a wild strawberry; but it is small and unattractive, so probably the fruit is better known (Fig. 146).

Observe:—

- (a) The fruit consists of numerous one-seeded bodies.
- (b) Each of these is prolonged into a thread, with a hook-like twist near the end of it.

These bodies are achenes, and the hooks act as a means of attaching them to the wool of sheep or anything that comes in contact with them; thus the seeds are dispersed.

3. A more striking example of this kind of device is furnished by the fruits of the hound's-tongue. Each fruit splits into four parts, all covered with very short strong hooks, which take hold so readily, that if they touch a person's clothes, they adhere at once, and can only be removed by picking off one at a time.

The harif or goosegrass, which grows in hedges, has a similar fruit.

4. Another, and perhaps more familiar example, is that of the burdock, Fig. 147. It is generally in favour with schoolboys. This plant bears its flowers in heads like the thistles, and the involucre persists round the fruit. It is the bracts of the involucre that are strongly hooked, and not the fruits themselves, but the purpose served is the same. Such fruits are often spoken of as *burrs*. Sanicle has a burred fruit.

### SEEDS WITH HAIRS.

1. We have seen that the seeds of the pine have thin wings to aid their flight; we shall now observe some other seeds that are assisted in a similar way.

2. Take the fruit of a willow herb. There are several kinds or species of this plant; one is called the French willow, and is cultivated; another codlins-and-cream, and there are smaller ones found as weeds. All are characterized by having the parts of the flowers in fours, and a very long slender inferior ovary. Fig. 148 shows the fruit after dehiscence into four valves; the middle point is what is left of the placenta, from which the valves have parted.

3. Observe the plumes of fine cottony hairs attached to each seed. The cotton from which calico is made is a similar growth, taken from the capsule of the cotton plant.



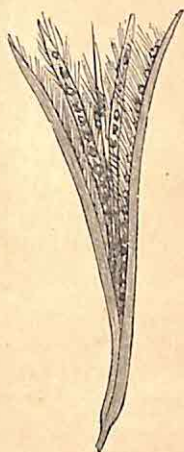


Fig. 148. Fruit of Willow Herb, opening, and showing seed-bearing down.

4. To many the cotton-sedge is well known. It grows on marshy lands, and is often gathered for stuffing cushions, etc. Wherever it grows, its white cottony heads are very noticeable. In this case, the hairs are not an outgrowth from the seeds, but a development of the perianths of the numerous flowers that grow close together, and like the pappus of many composites.

#### MECHANICAL EJECTION.

1. Some fruits are so constructed, that on drying, the seeds are ejected from the pericarp. Such instances we have seen in the pea and the crane's-bill. It now only remains to notice two more.

2. Watch the fruit of the violet after dehiscence, as shown in Fig. 149. Soon the valves, by drying, close up, and in so doing, throw out the seeds.

3. Again, notice the balsam, which is now often grown in cottage gardens. On touching the tip of the fruit when ripe, dehiscence immediately takes place, the valves curl up, and the seeds are thrown in all directions.



Fig. 149. Fruit of Violet, showing seeds held in valves of fruit, ready for ejection.

## SUMMARY.

The dispersion of seeds is effected :—

1. By fruits having a succulent pericarp, or a succulent growth round them, *e.g.*, berries, hips, sloes, etc.
2. By the fruits having wings or plumes of hairs, *e.g.*, sycamore, samara, dandelion, thistle, cotton-sedge.
3. By burrs or hooks, *e.g.*, burdock, hound's tongue, herb Bennet.
4. By the seeds having wings, *e.g.*, pine.
5. By the seeds having down or cotton, *e.g.*, cotton, willow herb.
6. By mechanical ejection, *e.g.*, violet, pea, crane's-bill, balsam.

Seeds are often preserved from destruction :—

1. By being covered with hairs unpalatable to those attempting to eat them, *e.g.*, achenes of rose.
2. By being poisonous, *e.g.*, seeds of yew.
3. By being hard and indigestible, *e.g.*, hawthorn.
4. By being surrounded by a hard indehiscent pericarp or testa, *e.g.*, nuts, and stone fruit. (Squirrels and monkeys are able to break these, but they often aid in dispersion, for they do not eat all they gather.)

## EXERCISE.

*Fill up schedules of any of the above fruits, and make complete schedules of various plants, taking all the parts present—root, stem, leaves, flowers, fruit.*

## LESSON XXI.

## A SUMMARY.

## CLASSIFICATION OF FRUITS.

1. All fruits may be divided into the two classes of

- (a) Superior,
- (b) Inferior.

But this would not suggest sufficient difference in character and structure.

2. We shall get a more useful classification if we arrange them in the first instance as :—

- A. Simple fruits—berries, etc.
- B. Collective fruits—mulberry, pine apple, etc.

3. Now let us take the simple fruits (from one flower); some are not merely the ripened ovary; so we have :—

- 1. True fruits (formed from the ovary only).
- 2. Not true fruits (pseudocarps)—pome, strawberry.

4. The true fruits are :—

- (a) Succulent.
- (b) Dry.

5. Taking first the succulent fruits, we have :—

The drupe—plum, blackberry.  
The berry—grape, orange, cucumber.

6. Coming to the dry fruits, we have :—

- |                                          |                               |
|------------------------------------------|-------------------------------|
| Dehiscent fruits of one carpel :         | pod or legume—pea.            |
|                                          | follicle—columbine.           |
|                                          | lomentum—sainfoin.            |
| Dehiscent fruits of two carpels :        | silique—wallflower.           |
|                                          | silicle—shepherd's purse.     |
| Dehiscent fruits of several carpels :    | capsule—poppy.                |
| Indehiscent fruits containing one seed : | nut—acorn, hazel.             |
| Indehiscent fruits containing one seed   | } achene—buttercup.           |
| in each separate carpel :                |                               |
| Indehiscent fruits containing several    | } splitting fruits } hogweed. |
| seeds :                                  |                               |
|                                          |                               |
|                                          | (schizocarp)—                 |
|                                          | samara—maple.                 |



The fruits of grasses, "hay-seeds," and grains of corn, though not true achenes, may be classed as such to avoid the introduction of further names. They are formed from two carpels, not from a single one, as an achene is.

Thus we bring our survey of the fruits to a close, having now completed our investigations of the outward forms and functions of a number of typical flowering plants. There are still many more that might well engage our attention, but sufficient has been done to start the little student on his own voyages of discovery. He should remember always to observe carefully, to record accurately, and not to come to conclusions without sufficient evidence. So far are we from having exhausted our subject, that we may say we are only on the threshold of it, and that there are more wonderful things in nature for the learner to discover than he has ever yet dreamt of.

END OF SECTION III.

SECTION IV.

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CLASSIFICATION.

# OBJECT LESSONS

FROM

Forest, Field, Wayside, and Garden.

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## LESSON I.

### PURPOSES OF CLASSIFICATION.

*A large variety of buttons, marbles, or other common objects.*

#### A BAG OF BUTTONS.

1. Here we have a bag of buttons of all shapes and sizes, of various materials, and made for various garments. Suppose we wish to say exactly what the bag contains, we must "sort" or classify them.

2. How shall we begin? In the first place we must observe something about them; *e.g.*, we soon see that some are made of bone, some of brass, some of steel, some of iron, some of cloth, etc. Or again, some have shanks, others are pierced with holes—two or four. Still again, some are coat buttons, some waistcoat buttons, some boot buttons. We may therefore sort or classify them first according to:—

- (a) The material of which they are made;
- or (b) The manner in which they are fastened;
- or (c) The article of apparel for which they are intended.

But we must take only one of these plans as our basis, or we shall soon find ourselves unable to carry out any useful classification.



3. Let us take that plan which will give us the smallest number of classes, or, to say the same thing in another way, let us see what property there is, the possession or non-possession of which, will divide them into *two* classes. With this end in view, we may arrange them as follows:—

(a) Those with shanks, or shanked buttons.

(b) Those with holes, or perforated buttons.

4. Then we shall see that each of these sets includes bone, brass, iron, pearl, and other buttons. So we may carry our classification further, and arrange the two sets as follows:—

A Shanked buttons of { bone (1)  
brass (2)  
iron (3)  
pearl (4)

B Perforated buttons of { bone (1)  
brass (2)  
iron (3)  
pearl (4)

We have here two sets, each containing four classes; and these we will put into boxes—eight boxes, or four to each set.

5. Now, before classifying further, we are able to describe the buttons in each of these boxes to the extent to which we have classified them. For instance, every one in B (2) is a brass perforated button. And in like manner, if we have a pearl shanked button, we at once put it into A (4).

### OTHER EXAMPLES.

1. In some such way as above, everybody who has large quantities of goods to deal with, must arrange them so that he may at once get what he wants without unnecessary trouble. Think too, of the arrangement of children in classes in school.

2. If we had a bag of marbles, we should probably arrange them according to the material of which they were made: stone, glass, earthenware, etc. Or if we had coins, it would perhaps be best to classify them as gold, silver, and bronze, to begin with.

## NECESSARY PRECAUTIONS.

1. But classification is not always as easy as it seems to be in the examples we have taken. We all make a kind of classification when we speak of animals as *birds, fishes, insects, reptiles, mammals, etc.*, and perhaps everybody has some notion of the differences that exist amongst these different groups. Let us test this knowledge. What is a bat? is it a bird? Before we can answer that question, we must agree on a definition of what a bird is. Suppose you say, "a bird is an animal that can fly"; then a bat is a bird, and so is a bee, a wasp, or a butterfly. And, again, a bat suckles its young, and has teeth; it must be a mammal. We should soon get hopelessly confused. We want a better definition, and to get that, we must study birds very closely to find out their characters; and we must study too the characters of other animals, before we can decide what shall be our definition for each class.

2. Is a spider an insect? is a whale a fish? These are questions we cannot answer until we have discovered (a) what are the characters possessed by the animals we call insects or fishes; (b) what are the characters of a spider and a whale. Thus, in order to classify animals correctly, we must know:—

- (a) In what respects animals are alike.
- (b) In what respects they differ from one another.
- (c) What we shall take as our plan or basis of classification.
- (d) How we shall define each class or section.

## USES OF CLASSIFICATION.

1. So we see:—

- (a) To classify correctly, exact and extensive knowledge is necessary.
- (b) Classification means a convenient or orderly way of arranging things.

But it is more than this. If a friend writes to me from Australia, to say that he has discovered a new insect, I at once know something about it from the mention of the simple word *insect*. I know it must be an animal having no bones; its body being



*insected*, or divided, as it were, into three parts; with six legs, and four or two wings (probably); that during its life it must pass through certain stages; that its body is in thirteen segments, and that it breathes through tubes. If further, he informed me that it was a scale-winged insect, I should know it was either a butterfly or a moth.

You see then, how much knowledge may be stored up in this one word, and a good classification is one that tells us as much as possible about the things classified, in the easiest possible way. Classification then becomes:—

- (a) A means of stating knowledge about things in an orderly way.
- (b) A store of knowledge for future use.

2. If you would understand the use of classification, try to think in what a condition our knowledge would be if we had no such names as *horse*, *sheep*, *cow*, *etc.*, but had to know every animal by a name of its own only. Thus you will see we get a notion of classification from the time when first we begin to use names. But it is only when our knowledge about things is perfect, that our classification can be perfect. We have gained a considerable knowledge of the characters of plants, and this knowledge we are now about to arrange and store up by using it to classify them, and so to have it as a basis for acquiring further knowledge.

## LESSON II.

### HOW TO CLASSIFY PLANTS.

#### SOME COMMON METHODS.

1. We have referred to the division of plants into the three classes: *annuals*, *biennials*, and *perennials*, as well as into *herbs*, *shrubs*, and *trees*. Although these methods are useful as far as they go, they do not go very far. Such names are given only from very slight observations, and do not convey any notion of the relation of plants to one another. For instance, there



grows in Africa, a tree thirty feet high, which botanists agree is a very near relative of the humble groundsel of our gardens. Or to take two better known plants, it would scarcely be thought by a casual observer, that the common chickweed was related to the sweet-scented garden pink or carnation. Yet botanists are quite agreed that such is the case. They are certainly both herbs, but they are not related on that account. Again the oak, which grows as a tree in our country, only reaches the height of a small shrub in some more northern countries.

2. Sometimes plants are spoken of as *wild* or *garden* plants. But often plants cultivated in one place, may be found wild in another. What we call weeds, are either those which grow so abundantly that they interfere with the growth of some which it is necessary to take great care of, or those which we have no special use for. They are plants that grow where they are not wanted.

### HOW SHALL WE CLASSIFY PLANTS?

1. Shall we be guided by the colours of the flowers? No, for we have both red and white roses, and while we should thus have to put white roses in the same class as white lilies, red roses would be grouped with poppies and red lilies. And we should gain nothing by such an arrangement.

2. Shall we consider the shapes of the leaves? Here we have something to go upon; for there is a great difference between the leaves of such as the grasses and plants like the oak and beech. But although these are characters that we shall consider, they are not the most important.

3. Let us consider what part of a plant we have found to be the most elaborate—the part in which the greatest differences were found, and in certain examples remarkable uniformity? That part is the flower—the flower composed of certain essential parts always present, certain other parts *usually* present, with its varying numbers of parts united or separate, as we have seen in many examples. It affords us the greatest variety of arrangement, indicates differences not suggested by other parts

of the plant, shows similarity otherwise not suspected. The arrangement of the organs and parts in a chickweed flower is exactly like that in the pink flower, but on a smaller scale. Thus both flowers have :—

- (a) Five sepals, inferior.
- (b) Five separate petals, growing below the ovary.
- (c) Ten separate stamens (chickweed often has only five).
- (d) A superior syncarpous ovary, with a central placenta.

### THE SYSTEM OF LINNÆUS.

The great Swedish botanist, Linnæus, who lived in the last century, and to whom we owe our botanical system of naming plants (which will be referred to later), devised a plan of classification based on the numbers and arrangement of parts in the flowers. He first classified all plants according to the number of stamens they had in each flower, thus :—

Class I.—One stamen,

Class II.—Two stamens,

and so on. Each class was again divided into groups, according to the number of carpels in each flower. He thus formed an excellent arrangement for grouping all known plants, but it had one great fault. Careful observation showed that it often brought into one group plants that could be shown by other characters not to be related, and it as frequently separated those which we now have decided ought to be placed together in one class. It was an artificial system, and as such was useful (see "Flowers of the Field," by the Rev. C. A. Johns). But it is now superseded by what is known as the Natural System, and which will be the subject of our next lesson.

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## LESSON III.

## THE "NATURAL" SYSTEM.

## ITS BASIS.

This system is called *natural* in contra-distinction to artificial plans, such as that of Linnæus referred to in our last lesson. Instead of being based upon one or two characters, as, for instance, the number of stamens, or the number of carpels, all the characters are taken into consideration, and botanists try to find by this means what plants are most nearly alike and what most different.

## EXAMPLES.—FAMILIES.

1. We have said that the *flower* presents the greatest variety of differences. These we have observed very closely in the lessons of Section III., and the flower will therefore receive a very large share of attention in classification.

2. Let us take a few examples.

(1.) Those plants having *composite* flowers. All these flowers :—

- (a) Grow in heads.
- (b) Have gamopetalous corollas of five petals.
- (c) Have five stamens on the corolla with syngenesious (united) anthers (when stamens are present).
- (d) Have inferior ovaries, each of two carpels.

(2.) Those plants with *papilionaceous* corollas. These flowers have :—

- (a) Papilionaceous corollas of five petals, not all united.
- (b) Ten stamens united by filaments (stalks), and growing round the ovary.
- (c) Superior ovaries, each of one carpel.

Moreover, the leaves of these latter plants are stipulate, while those of the former are not.

3. We have seen a large number of plants having flowers with the characters enumerated in (1), and we have also seen



several flowers with the characters of (2). It is no mere accident that a daisy, a dandelion, and a coltsfoot have the flowers which we call composites; we are sure that they must be much more closely related to one another than they are to the pea-flower plants, whose characters we have taken as a second example. We have thus to begin with two groups:—

(a) The composite group or *family*.

(b) The pea-flower group or *family*.

4. We will take two more examples.

(3.) The foxglove and snapdragon. Both plants have:—

(a) Corollas of five united petals.

(b) Four stamens on the corolla.

(c) Two-celled superior ovaries, with axile placentas.

(d) No stipules.

(4.) The violet and pansy. Both plants have:—

(a) Corollas of five separate petals.

(b) Five stamens growing below the ovary.

(c) Superior ovaries, with walled placentas.

(d) Stipulate leaves.

5. Again we at once see that the foxglove and snapdragon must be much more closely related to one another than they are to the pansy and violet; and that each of these groups is distinct from examples (1) and (2). So we have two more groups or families as they are called:—

(a) The foxglove family.

(b) The violet family.

6. In this way we could go on to point out several groups or families quite easily, as, for instance, the wallflower family, the buttercup family, etc.

## LARGER GROUPS.

1. Continuing thus, we might plan out a considerable number of families; but we must not forget that we could not do so accurately, unless we defined exactly what should be the limits of each; and to do that we must have examined all the flowers

known. Botanists have done this, and are now doing it for us; so what we have to do is to try to understand the plan on which they have worked out the classification.

2. Let us take another glance at the examples we have already made use of. Comparing the four families, we observe that even amongst them there are points of similarity—the foxglove more nearly resembles the composites than the pea-flower or violet families, for:—

(a) The composites and foxgloves have both gamopetalous corollas with stamens growing on them.

(b) The violet and pea have both apopetalous corollas.

And we might add several other families to each of these larger groups, and so form two groups of families:—

(a) The apopetalous group.

(b) The gamopetalous group.

3. Then we have seen such flowers as those of the oak and hazel which have no corollas, and as there are several families of these, we have a third—the incomplete group.

All these groups have certain characters in common which distinguish them from other families of which we have not spoken in this lesson.

## CLASSES.

1. In a previous lesson it was shown how nearly all flowering plants fall into two great classes:—

(a) Dicotyledons.

(b) Monocotyledons. (Less. VII., Sec. III.)

2. A buttercup, dandelion, and foxglove, although differing very considerably, have these characters in common:—

(a) Net-veined leaves.

(b) Flowers with parts in fives.

(c) Two cotyledons in the embryo.

All three are therefore dicotyledons.

3. There are two other differences which help to mark off these two great classes, and show us that the division is a

natural one. (Examine a germinating seed.) Dicotyledons have:—

More or less tapering or *tap* roots, these being formed by the continued lengthening of the root end or *radicle* of the embryo.

(Examine a germinating grain of wheat or plant grown in water.) Monocotyledons have:—

More or less fibrous roots. The radicle does not lengthen, but branching roots are given off all round it.

It will be shown later in lessons dealing with structure, that the wood of the stem and root is differently formed in these two classes. In dicotyledons, it grows in layers, so that when a stem or trunk is cut, successive rings are seen. These are very evident in felled trees. If you cut a cane you find no trace of any such structure. The stems of monocotyledons do not thicken year after year.

4. In conclusion, we will summarize these important differences:—

|         | MONOCOTYLEDONS.                   | DICOTYLEDONS.                                           |
|---------|-----------------------------------|---------------------------------------------------------|
| Embryo. | One cotyledon.                    | Two cotyledons.                                         |
| Root.   | Fibrous, radicle not lengthening. | Usually tapering, radicle lengthening.                  |
| Leaves. | Parallel-veined.                  | Net-veined.                                             |
| Flower. | Parts in <i>threes</i> .          | Parts in <i>twos</i> , <i>fours</i> , or <i>fives</i> . |
| Wood.   | Not formed in layers or rings.    | Formed in layers or rings.                              |

---



## LESSON IV.

## THE "NATURAL" SYSTEM.

(CONTINUED.)

*Lily, grass in flower, wheat grown in water.*

## THE VEGETABLE KINGDOM.

1. We have on a former occasion spoken of plants as forming what is called the vegetable kingdom. This includes not only such as have been the subject of our lessons, but also ferns, mosses, mushrooms or toad-stools, moulds, and sea-weeds.

2. We have been concerned with what are commonly called flowering plants. Now these plants all produce seeds for the purpose of reproduction; and it is well to recall at this point what a seed is—a piece of a plant given off for reproduction and containing an embryo or plantlet.

3. But such plants as ferns and mosses produce no seeds; reproduction is accomplished by means of spores; in fact, their whole life history appears to be so different from that of the plants whose acquaintance we have made, that a consideration of such must be left to a later stage, opening up as it does a field even greater than the one which we have to some extent explored.

4. On the basis of what we have considered this lesson, we can divide the whole kingdom into two great groups:—

(a) Group I. Seed plants.

(b) Group II. Plants not seed bearing.

It is, however, more usual now to make three groups of the latter, placing them first and ranking the seed plants as Group IV. Whichever plan be followed, it is with this last that we are now concerned.

## SEED PLANTS. (Flowering Plants.)

1. Now these seed-bearing plants are divided into two sections,

one small and the other comparatively large. In observing the fruit of the pine—cones as they are called—we noticed that the seeds were not contained within a pericarp; the ovules of the flower not within an ovary; in other words, the seeds are naked. The same was seen in the yew. This striking difference is not the only one; it is accompanied by differences in the wood growth and the number of cotyledons in the embryo, there being usually about fifteen.

2. SEED-BEARING plants thus fall into two sections.

A. Those having naked seeds.

B. Those having seeds enclosed within a pericarp.

3. All plants then having their seeds formed not within an ovary are classed in this first section, and are called GYMNOSPERMS, a name which means *naked-seeded*,—a small section including *pin*es, *firs*, *yews*, etc.

All other seed plants form the second section, and are called angiosperms, or plants whose seeds are *within a pericarp*. As this is a very large section, its classification is carried out to a much greater extent, as we shall now proceed to show.

B. ANGIOSPERMS.

These fall into the two great classes:—

I. MONOCOTYLEDONS.

II. DICOTYLEDONS.

I. MONOCOTYLEDONS.

1. Examine a lily and a grass. Both will be found to be monocotyledons, but they represent two sub-classes.

(a) Those with a perianth either petaloid as in the lily, or sepaloid as in the rush.

(b) Those with only a covering of chaffy bracts or glumes.

2. Each of these sub-classes includes several families or "Natural Orders," as they are generally called.

II. DICOTYLEDONS.

1. This class embraces such diverse plants as the oak, buttercup, and foxglove, each one being a type of a section.



The buttercup and foxglove have each a *double perianth*, that is, a calyx and corolla, while the oak has none. Some flowers, again like those of the elm, have a single perianth.

2. The dicotyledons then fall into two sub-classes.

(a) Those having flowers with a double perianth.

(b) Those having flowers with a single perianth or none (Incomplete).

And as these again fall into groups the following table will best show their relations :—

|                                            |                                                              |                                     |                |
|--------------------------------------------|--------------------------------------------------------------|-------------------------------------|----------------|
| DOUBLE<br>PERIANTH.<br>(Tables III. & IV.) | ° { Apopetals<br>(or Polypetals.)<br>Gamopetals. (Table IV.) | { Thalamiflorals.<br>Calyciflorals. | { (Table III.) |
| Incomplete.<br>(Table II.)                 | { Single perianth.<br>No perianth.                           |                                     |                |

3. But sufficient has been said to show the lines on which the classification proceeds. Full tables of the families are given, simplified as much as possible, and these will be followed by lessons showing how to use them. It is not intended that they should be learnt off by heart. On the contrary, the natural and proper way to become acquainted with them is to use them as directed in the remaining lessons of this book.

Table I. embraces the monocotyledons.

„ II. the *Incomplete* division of the dicotyledons.

„ III. the *apopetalous* dicotyledons.

„ IV. the *gamopetalous* dicotyledons.

*Note.*—The terms *polypetals* and *polypetalous* are common in most Botany books, instead of *apopetals* and *apopetalous* as used throughout this book; but the latter are sometimes met with and seem to me more apt.

*Thalami-florals*: Stamens grow below the ovary on the receptacle or *thalamus*.

*Calyci-florals*: Stamens grow on the *calyx* round the ovary.



TABLE I. (British Plants).

## MONOCOTYLEDONS.

| DIVISION PETALOID                                                                                                                                                                                                                       |                                                                                                                                                                                                                                                | DIVISION GLUMACEOUS                                                                                                                                                                                                                                                                |                                                                                                                                                                 |
|-----------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------|------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------|------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------|-----------------------------------------------------------------------------------------------------------------------------------------------------------------|
| Having a perianth or covering; or O                                                                                                                                                                                                     |                                                                                                                                                                                                                                                | Having chaffy bracts                                                                                                                                                                                                                                                               |                                                                                                                                                                 |
| Covering scaly, or O                                                                                                                                                                                                                    | Covering petaloid                                                                                                                                                                                                                              |                                                                                                                                                                                                                                                                                    |                                                                                                                                                                 |
|                                                                                                                                                                                                                                         | Ovary superior                                                                                                                                                                                                                                 | Ovary inferior                                                                                                                                                                                                                                                                     |                                                                                                                                                                 |
| <p>75 Bulrush Family.<br/>Flowers in dense heads or spikes.<br/>Fruit, a nut.</p> <p>76 Arum Family.<br/>Fruit, succulent.</p> <p>77 Duckweed Family.<br/>No stems.<br/>Floating.</p> <p>78 Naiad Family.<br/>Floating.<br/>A stem.</p> | <p>79 Water Plantain Family.<br/>Carpels separate.</p> <p>85 Lily Family.<br/>Perianth petaloid.<br/>Carpels united, three.</p> <p>86 Rush Family.<br/>Perianth stiff or sepaloid.<br/>Carpels united, three.</p> <p>87 Eriocaulon Family.</p> | <p>80 Hydrocharis Family.<br/>Floating plant</p> <p>81 Orchid Family.<br/>Perianth irregular, one or two stamens and pistil combined.</p> <p>82 Iris Family.<br/>Stamens three.</p> <p>83 Daffodil Family.<br/>Stamens six.</p> <p>84 Black Bryony Family.<br/>Climbing plant.</p> | <p>88 Sedge Family.<br/>Leaf sheaths entire.<br/>Flower in axil of one bract.</p> <p>89 Grass Family.<br/>Leaf sheath split.<br/>Each flower in two bracts.</p> |

The numbers are those of Bentham and Hooker's "British Flora."

TABLE II. (British Plants).

## DICOTYLEDONS.

## DIVISION INCOMPLETE.

| <i>Having perianth</i>                                                      | <i>Having no perianth</i>                                                                                                                                                |
|-----------------------------------------------------------------------------|--------------------------------------------------------------------------------------------------------------------------------------------------------------------------|
| 61 <b>Paronychia</b> Family.<br>Herbs. Flowers perfect. Stipules.           | 68 <b>Spurge</b> Family.<br>Herbs.                                                                                                                                       |
| 62 <b>Goosefoot</b> Family.<br>Herbs. Perfect flowers. No stipules.         | 70 <b>Water Star-wort</b> Family.<br>Aquatic herbs.                                                                                                                      |
| 63 <b>Dock</b> Family.<br>Herbs. Perfect flowers. Sheathing stipules.       | 73 <b>Catkin</b> Family.<br>Trees. Some of this family have a perianth, others none.                                                                                     |
| 64 <b>Daphne</b> Family.<br>Shrubs. One carpel.                             |                                                                                                                                                                          |
| 71 <b>Nettle</b> Family.<br>Herbs. Stamens and pistil in different flowers. |                                                                                                                                                                          |
| 72 <b>Elm</b> Family.<br>Trees. Two carpels, two seeds.                     | 74 <b>Pine</b> Family.<br>Trees. Leaves stiff or scale-like.<br>No ovary or pericarp.<br>( <i>Belong to the section Gymnosperms, only placed here for convenience.</i> ) |
| 73 <b>Catkin</b> Family.<br>Trees. Two carpels, one seed.                   |                                                                                                                                                                          |
| <i>Stamens ∞.</i>                                                           |                                                                                                                                                                          |
| 1 <b>Buttercup</b> Family.<br>Some exceptional genera. Stamens on thalamus. |                                                                                                                                                                          |
| 26 <b>Rose</b> Family.<br>Some exceptional genera. Stamens on calyx.        |                                                                                                                                                                          |

TABLE III. (British Plants).

## DICOTYLEDONS . . . . .

*Thalamiflorals* | *stamens under ovary*

*Carpels* | *separate*

*Carpels* | *united*

*Placenta* | *walled*

*Not* | *walled*

- |                                                                                                                                                                                                                                            |                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                           |                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                         |
|--------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------|---------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------|---------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------|
| <p>1 <b>Buttercup Family.</b><br/>Stamens <math>\infty</math>.<br/>Petals definite.</p> <p><b>Barberry Family.</b><br/>Stamens six.</p> <p>3 <b>Water-lily Family.</b><br/>Aquatic plants.<br/>Petals and Stamens <math>\infty</math>.</p> | <p>4 <b>Poppy Family.</b><br/>Petals four.<br/>Stamens <math>\infty</math>.</p> <p>5 <b>Fumitory Family.</b><br/>Irregular.<br/>Stamens six, united<br/>by filaments.</p> <p>6 <b>Crucifer Family.</b><br/>Stamens six; four<br/>long, two short.</p> <p>7 <b>Mignonette Family.</b><br/>Irregular.<br/>Petals four to six,<br/>divided.</p> <p>8 <b>Rock-rose Family.</b><br/>Petals five, regular.<br/>Stamens <math>\infty</math>.</p> <p>9 <b>Violet Family.</b><br/>Irregular.<br/>Stamens five.</p> <p>11 <b>Frankenia Family.</b><br/>Leaves opposite, entire.</p> | <p>10 <b>Milkwort Family.</b><br/>Stamens eight, united.</p> <p>12 <b>Pink Family.</b><br/>Placenta central.<br/>Sepals four or five.</p> <p>13 <b>Purslane Family.</b><br/>As pink, sepals two.</p> <p>16 <b>Hypericum Family.</b><br/>Stamens in three or<br/>five bundles.</p> <p>17 <b>Flax Family.</b><br/>Capsule many-celled.<br/>Stamens five.</p> <p>18 <b>Mallow Family.</b><br/>Stamens <math>\infty</math>, united<br/>by filaments.</p> <p>19 <b>Lime-tree Family.</b><br/>Trees.<br/>Stamens <math>\infty</math>.</p> <p>20 <b>Geranium Family.</b><br/>Stamens five or ten.<br/>Carpels round a persistent axis.</p> <p>21 <b>Maple Family.</b><br/>Trees.<br/>Stamens usually eight</p> |
|--------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------|---------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------|---------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------|



## . DIVISION APOPETALS.

*Calyciflorals* | *stamens round or on the ovary*

*Stamens* | *on calyx*

*Stamens* | *on ovary or petals*

- |                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                     |                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                     |
|-----------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------|-----------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------|
| <p>23 <b>Spindle Tree Family.</b><br/>Shrub. Flowers minute. Stamens alternate with petals.</p> <p>24 <b>Buckthorn Family.</b><br/>Shrubs. Flowers small. Stamens opposite petals.</p> <p>25 <b>Pea Family.</b><br/>Herbs or shrubs. Corolla papilionaceous. One carpel. Stamens ten.</p> <p>26 <b>Rose Family.</b><br/>Herbs or shrubs. Flowers regular. Carpels separate.</p> <p>27 <b>Willow Herb Family.</b><br/>Herbs. Ovary inferior. Stamens two, four, or eight.</p> <p>28 <b>Loosestrife Family.</b><br/>Herbs. Stamens six or twelve.</p> <p>29 <b>Cucumber Family.</b><br/>Climbing. Stamens and pistil in separate flowers.</p> <p>30 <b>Stone Crop Family.</b><br/>Herbs. Leaves fleshy. Ovary superior. Carpels nearly separate, as many as petals.</p> <p>31 <b>Currant Family.</b><br/>Shrubs. Ovary inferior. Fruit succulent.</p> | <p>22 <b>Holly Family.</b><br/>Tree. Ovary, four-celled.</p> <p>35 <b>Umbellate Family.</b><br/>Herbs. Stamens five, on ovary. Carpels two.</p> <p>36 <b>Ivy Family.</b><br/>Climbing. Carpels five.</p> <p>37 <b>Mistletoe Family.</b><br/>Parasite.</p> <p>38 <b>Dogwood or Cornel Family.</b><br/>Shrubs or herbs. Ovary two-celled.</p> <hr/> <p>(These belong to previous column.)</p> <p>32 <b>Saxifrage Family.</b><br/>Herbs. Ovary half inferior. Stamens five, eight, or ten.</p> <p>33 <b>Sundew Family.</b><br/>Herbs. Radical leaves, with glandular hairs.</p> <p>34 <b>Marestail Family.</b><br/>Aquatic plants. Flowers minute.</p> |
|-----------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------|-----------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------|

TABLE IV. (British Plants).

## DICOTYLEDONS. DIVISION GAMOPETALS.

| Ovary inferior                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                             | Ovary superior                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                       |                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                          |
|--------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------|--------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------|----------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------|
|                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                            | Corolla regular                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                      | Corolla irregular                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                        |
| <p>39 <b>Honeysuckle Family.</b><br/>Herbs or shrubs.<br/>Ovary three to five celled.<br/>Stamens epipetalous.</p> <p>40 <b>Stellate tribe of Mad-<br/>der Family.</b><br/>Leaves apparently four, six, or eight in a whorl.<br/>Ovary two-celled.<br/>Stamens epipetalous.</p> <p>41 <b>Valerian Family.</b><br/>Herbs.<br/>One ovule.<br/>Stamens one or three.</p> <p>42 <b>Teasel Family.</b><br/>Herbs.<br/>Ovary one-celled.<br/>Stamens five separate</p> <p>43 <b>Composite Family.</b><br/>Herbs.<br/>Ovary one-celled.<br/>Stamens five.<br/>Anthers united.</p> <p>44 <b>Campanula Family.</b><br/>Herbs.<br/>Stamens joined to ovary.</p> <p>45 <b>Heath Family (part).</b><br/>Small shrubs.<br/>Stamens joined to ovary.</p> | <p>45 <b>Heath Family.</b><br/>Shrubs or herbs.<br/>Stamens free from corolla.</p> <p>46 <b>Primrose Family.</b><br/>Herbs.<br/>Stamens opposite petals.<br/>Placentation central.</p> <p>48 <b>Olive Family.</b><br/>Tree or shrub.<br/>Stamens two.</p> <p>49 <b>Periwinkle Family.</b><br/>Herbs.<br/>Two carpels united by styles.</p> <p>50 <b>Gentian Family.</b><br/>Herbs.<br/>Leaves opposite.<br/>Placenta walled.</p> <p>52 <b>Convolvulus Family.</b><br/>Herbs.<br/>Leaves alternate.<br/>Sepals separate.</p> <p>53 <b>Borage Family.</b><br/>(See next column.)</p> <p>54 <b>Nightshade Family.</b><br/>Herbs; as in 56, but fruit a berry or capsule.<br/>Stamens as many as lobes of corolla.</p> <p>56 <b>Scrophularia Family.</b><br/>(Verbascum or Veronica).<br/>Stamens five or two.<br/>Fruit, a capsule.</p> | <p>53 <b>Borage Family.</b><br/>Ovary four-lobed.<br/>Stamens five.</p> <p>55 <b>Broom-rape Family.</b><br/>Leafless parasites.</p> <p>56 <b>Scrophularia Family.</b><br/>Stamens four.<br/>Ovary two-celled.<br/>Many ovules.</p> <p>57 <b>Labiata Family.</b><br/>Ovary four-lobed.<br/>Stamens two or four.</p> <p>58 <b>Vervain Family.</b><br/>Ovary one-celled.</p> <p>47 <b>Pinguicula Family.</b><br/>Aquatic.<br/>Stamens two.<br/>Ovary one-celled.</p> <hr/> <p>(These belong to previous column.)</p> <p>59 <b>Plumbago Family.</b><br/>Stamens opposite petals.<br/>One ovule.</p> <p>60 <b>Plantain Family.</b><br/>Dry stiff corolla.</p> |

## LESSON V.

## HOW TO FIND THE FAMILY OF A PLANT.

*A foxglove in flower.*

## PRELIMINARY.

1. It may be well to say once more that these tables are not intended to be committed to memory. The use of them on the lines laid down in this lesson will achieve all that is desirable in this direction. They contain all the families of British Flowering or Seed Plants, with the exception of seven or eight rare and poorly-represented families. The Botanical names have not been given here, they will be found in an Appendix. The numbers are those given in Bentham and Hooker's "British Flora," which should be referred to for further detail. (See Appendix B.)

2. If the pupil has the tables in his hands he will work as below ; if not, his schedules should be filled up, and the plant run down as far as possible before presenting it for closer reference. In a school the tables might be written out and posted up on the wall of the class room.

## FIRST—CAREFUL OBSERVATION EXACTLY RECORDED.

The whole plant must be described. If the points of the leaf and stem schedules can be remembered, the form may be dispensed with and the flower and fruit schedule abbreviated as below ; let us begin with the foxglove :—

**Plant.** Biennial.

**Root.** Tapering, much branched, and fibrous.

**Stem.** Herbaceous, becoming woody below, round, erect, stout, two to six feet.

**Leaves.** Radical and cauline, petiolate, exstipulate, alternate, net-veined, simple, entire, large, ovate, downy, and slightly hoary.

**Inflorescence.** Simple, one-sided raceme, of large purple flowers, with small leafy bracts.



## FLOWER AND FRUIT SCHEDULE.

| Organs and Parts.           | No.                  | Cohesion.    | Adhesion.   | Remarks.                            |
|-----------------------------|----------------------|--------------|-------------|-------------------------------------|
| Calyx<br><i>Sepals</i>      | 5                    | Gamosepalous | Inferior    | The upper one smaller               |
| Corolla<br><i>Petals</i>    | 5                    | Gamopetalous | Under ovary | Two-lipped<br>Four-lobed            |
| Andrœcium<br><i>Stamens</i> | 4                    | Separate     | Epipetalous | Two long, two short<br>(Didynamous) |
| Gynœcium<br><i>Carpels</i>  | 2                    | Syncarpous   | Superior    | Placenta axile                      |
| Fruit                       | A two-celled capsule |              |             |                                     |
| Seed                        | Small and numerous   |              |             |                                     |

## DIAGRAMS.

1. We will now make a floral diagram to show the relative position and number of parts in the flower. Imagine what you would see if a flower were cut horizontally or across when held upright; then make a drawing of the cut edges, or to show the parts represented by the cut edges.

2. Take a penny or other round object suitable and make a ring on your paper; then two others inside it and concentric with it. On the outer, mark thick lines to represent the position of the sepals; on the second, similar lines to represent the

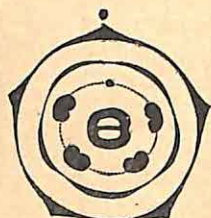


Fig. 150. Floral diagram of the Foxglove. The dot above indicates the stem or axis of the plant, and therefore the "back" of the flower.

- petals (these will alternate with the sepals); on the third ring mark the stamens as shown in Fig. 150. These it should be observed are opposite to the sepals, and the back one is missing, as we have seen before, so it must be represented by a dot. Then represent the carpels as seen in section.

3. *A diagram of this kind should now always be made as a part of the record after examining a flower. In a class a large drawing should be put on the black board.*

## LESSON VI.

### HOW TO FIND THE FAMILY OF A PLANT.

(CONTINUED.)

#### FLORAL FORMULA.

1. In the last lesson we got all our matter together; we recorded sufficient to be able to proceed now, without plant or flower, to find out the family and relations of the plant.

2. Before doing so it may be pointed out that it is very advantageous to summarize the chief facts connected with the flower in a way suitable for comparison with other results.

3. Let K stand for calyx, C for corolla, A for the stamens, and G for the pistil. *A* is the initial letter of the word *Andræcium*, a term now generally used by botanists for the whole of the stamens, just as calyx is used for the whole of the sepals. Similarly G stands for *Gynæcium*, a term likewise used for the whole of the carpels of a single flower. It means nothing more than the pistil, as the word has been used in these lessons. As, however, the word is made to correspond to *Andræcium*, and its initial letter is used as indicated above, it is perhaps as well that it should be introduced.

4. Taking then these letters and using figures to represent the numbers of the parts of each, we make up what is called a *floral*

formula for the foxglove, thus :—

K(5.) C(5.) A(4.) G(2).

The brackets denote that the parts for which the figures stand are united. K(5) means a calyx of five united sepals. K 5 would represent a calyx of 5 separate sepals, and so on. Notice the 2 for the carpels is not only enclosed because the ovary is syncarpous, but that it is placed *above* a little horizontal line; this is to show that the ovary is superior. An inferior ovary of two carpels would be represented thus G( $\frac{2}{-}$ ).

5. So it will be seen, the floral diagrams and formulæ are concise ways of representing to the eye the results of observation.

### “RUNNING DOWN.”

1. Having now all our facts marshalled and well in hand we proceed as follows :—

(a) Is the seed developed in an ovary or naked? In an ovary, therefore the plant is an *Angiosperm*, and so it is either a diocotyledon or a monocotyledon.

(b) Are the leaves parallel or net-veined?  
the flower parts in fives or threes?  
the cotyledons one or two? (*This cannot always be answered.*)

The leaves are net-veined, the flower parts in fives; this is sufficient to tell us it is a *Dicotyledon*.

(c) Is the perianth double or single, *i.e.*, does the plant belong to the Incomplete Division or not?

*Double perianth*, therefore it is either a gamopetal or apopetal.

(d) Corolla apopetalous or gamopetalous? *Gamopetalous.*

(e) Ovary superior or inferior? *Ovary superior.*

2. We may now refer to Table IV., from which we see that our plant belongs to one of the families in either the second or the third column. To decide which we must answer the question, is the corolla regular or irregular? It is *irregular*, consequently, the family is one of the six in the third column (for the two at the bottom belong to column 2).

3. Read the few words of description attached to each, and see



which describes exactly, as far as it goes, the plant we are considering. There is only one description to which it answers, and that is "stamens four, ovary two-celled, many ovules." Hence the foxglove belongs to the—

### SCROPHULARIA FAMILY.

#### THE FAMILY.

This is so called on account of a plant of the name which belongs to it, and is believed to have received such a name from the fact that it was formerly used as a medicine for the disease called scrofula.

The family generally is not a useful one, and the foxglove itself is poisonous.

### LESSON VII.

## THE SNOWDROP.

(HOW TO KEEP RECORDS.)

*Full plant, with flowers. Knife, glass, and needle.*

#### REMARK.

The student should not begin to seek out rare flowers, until he has, by exercise with familiar forms, made himself ready at detecting all points that come under his observation. We will, as another example, take the little snowdrop.

#### HOW TO KEEP RECORDS.

Take a sheet of paper or page of an exercise book, and work out as follows:—

February 16th, 1894.

Foley Farm, Tetley Cross.

In an upland meadow.

**Plant**—A bulbous herb, with a single flower, growing with others in clumps among the grass.

**Root**—Fibrous.

**Stem**—(Rootstock) a small bulb.

**Leaves**—Two, radical, linear, entire, parallel-veined, glabrous, in a membranous sheath at the base.

**Inflorescence**—Solitary, on a scape.\*

**Flower**—Drooping, on a slender pedicel.

### FLOWER AND FRUIT SCHEDULE.

| Organs.                     | No.          | Cohesion.  | Adhesion.  | Remarks.                        |
|-----------------------------|--------------|------------|------------|---------------------------------|
| Calyx<br><i>Sepals</i>      | 3            | } Separate | Superior   | A petaloid Perianth             |
| Corolla<br><i>Petals</i>    | 3            |            |            |                                 |
| Andrœcium<br><i>Stamens</i> | 3+3          | Separate   | Upon ovary | Anther opening by pores at top. |
| Gynœcium<br><i>Carpels</i>  | 3            | Syncarpous | Inferior.  | Placenta, axile                 |
| Fruit                       | None present |            |            |                                 |
| Seed                        | None present |            |            |                                 |

### FLORAL FORMULA.

{K3 C3.}, A3+3, G(3).

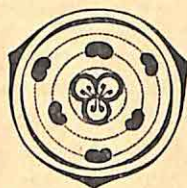


Fig. 151. Floral diagram of Snowdrop.

\* A leafless peduncle springing from a rootstock.

- (1) As the ovules are contained in an ovary, the plant is either a Monocotyledon or Dicotyledon.
- (2) The parallel-veined leaves, and the parts of the flower in threes, show it to be a *Monocotyledon*.
- (3) The perianth shows that it belongs to the *Petaloid* division.
- (4) The inferior ovary and six stamens assign it to the

DAFFODIL FAMILY

### THE FAMILY.

1. A reference to the Flora would give further detail, and its Botanical name.

2. The daffodil should next be examined, and special notice taken of the large growth from the throat of the perianth—a tube looking like a gamopetalous corolla. It is called a corona. Notice, too, the large scarious bract or *spathe* surrounding the ovary. The daffodil, snowdrop, and white narcissus, are all beautiful flowers, and bloom in winter or early spring. The last is not native, but has been brought from the Mediterranean region.

## LESSON VIII.

### EXERCISES.

1. The following is a brief botanical description of a plant; read it carefully, and find out, as in the last lesson, to what family the plant belongs.

*Stem.* Herbaceous, or woody, in the lower part, covered with small appressed hairs, erect, angled, perennial.

*Leaves.* Cauline, alternate, sessile narrow lanceolate, entire, exstipulate.

*Inflorescence.* Erect many-flowered racemes, ebracteate.

*Floral formula.*  $K_{2+2}, C_4, A_{2+4}, G^{(2)}$ .

*Floral diagram.*



Fig. 152.

2. Fill up a complete schedule for the plant figured in the frontispiece by reference to the drawing only; ascertain its family and name also if possible.



|                                                                                                                                                                                                                                                                              |                                                                                                  |             |             |            |
|------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------|--------------------------------------------------------------------------------------------------|-------------|-------------|------------|
| Date                                                                                                                                                                                                                                                                         |                                                                                                  |             |             |            |
| Locality                                                                                                                                                                                                                                                                     |                                                                                                  |             |             |            |
| Root                                                                                                                                                                                                                                                                         | Small growing from rhizome.                                                                      |             |             |            |
| Stem                                                                                                                                                                                                                                                                         | Rhizome underground.                                                                             |             |             |            |
| Leaves                                                                                                                                                                                                                                                                       | Radical, with long petioles, exstipulate, net-veined, compound of three deeply-divided leaflets. |             |             |            |
| Inflorescence                                                                                                                                                                                                                                                                | Solitary on a scape, with three large leafy bracts.                                              |             |             |            |
| Flower                                                                                                                                                                                                                                                                       |                                                                                                  |             |             |            |
| Organs and Parts                                                                                                                                                                                                                                                             | No.                                                                                              | Cohesion.   | Adhesion.   | Remarks.   |
| Calyx<br><i>Sepals</i>                                                                                                                                                                                                                                                       | 6                                                                                                | Aposepalous | Inferior    | (Petaloid) |
| Corolla<br><i>Petals</i>                                                                                                                                                                                                                                                     | 0                                                                                                | —           | —           | —          |
| Andrœcium<br><i>Stamens</i>                                                                                                                                                                                                                                                  | $\infty$                                                                                         | Separate    | Under ovary |            |
| Gynœcium<br><i>Carpels</i>                                                                                                                                                                                                                                                   | $\infty$                                                                                         | Apocarpous  | Superior    |            |
| Fruit                                                                                                                                                                                                                                                                        | Not present                                                                                      |             |             |            |
| Seed                                                                                                                                                                                                                                                                         | Not present.                                                                                     |             |             |            |
| Floral Formula— $K_6, C_0, A_\infty, G_\infty$ .                                                                                                                                                                                                                             |                                                                                                  |             |             |            |
| <p><i>Class:</i> (parts of flowers <math>\infty</math>). Dicotyledon.</p> <p><i>Division:</i> Incomplete.* <i>Sub-division:</i> With perianth.</p> <p><i>Order or Family:</i> (Stamens <math>\infty</math>, under ovary). BUTTERCUP FAMILY.</p> <p><i>Name:</i> Anemone.</p> |                                                                                                  |             |             |            |
| <p>* Strictly belonging to the Apopetalous Division; being one of the exceptional genera. (See Flora.)</p>                                                                                                                                                                   |                                                                                                  |             |             |            |

## LESSON IX.

## THE SPOTTED ORCHIS.

*Whole plant, flowers : flowering time, spring and early summer : found in marshy ground.*

## GENERAL CHARACTERS.

1. This plant is taken here as a type of the family which has such remarkable distinctive characters that it ought not to be passed over. The spotted orchis is known by the spots on its leaves ; if it cannot be obtained, one of the others, green orchis, bee orchis, butterfly orchis, or a foreign specimen from a greenhouse, should be substituted. There are thirty-seven British species.

2. Assuming we have a spotted orchis, we examine and fill up a schedule like the one used in the last lesson. Notice :—

- (a) *Roots*, tuberous.
- (b) *Leaves*, parallel-veined, radical and cauline, and marked with dark spots, entire.
- (c) *Inflorescence*, a dense raceme of purple or pink flowers.

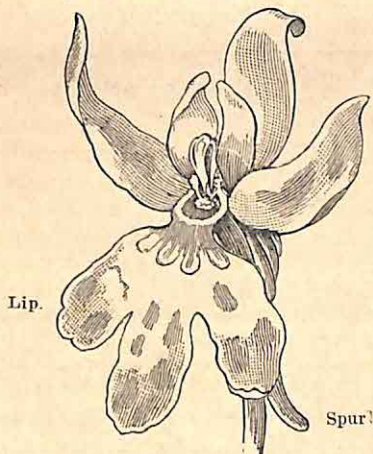


Fig. 153. Flower of Spotted Orchis (twice nat. size).

**THE FLOWER—ITS PERIANTH.**

1. The flower has obviously :—

- (a) A six-leaved irregular perianth ; three inner, three outer leaves.
- (b) The front leaf large, three-lobed, and spreading, with a long spur.
- (c) An inferior ovary.

2. Observe the ovary. There is a twist in it which has the effect of bringing the posterior part of the flower to appear anterior. Thus the large spurred lip is in the *posterior petal*.

**STAMEN AND PISTIL.**

1. Take a sharpened lead pencil, and carefully insert the point in the tube or inside of the spur, pushing it as far as possible. If it be a newly-opened flower, on withdrawing the pencil, there will be found adhering, two elongated club-shaped masses of pollen.

2. Looking into the flower, two upright cavities will be seen, from which the pollen masses have been taken. Notice that the pollen masses continue to adhere to the pencil, but gradually incline forwards towards the point.

3. Now insert the pencil, with the adhering pollen masses, in the tube of one of the other flowers. It will be seen that these masses of pollen come in contact with a sticky surface at the top of the tube or spur, just below a projecting lump at the base of the pollen cavities, and become attached either wholly or partially.

4. What have been seen are as follows :—

- (a) The pollen cavities are two anthers.
- (b) The sticky surface is the stigma.
- (c) The projecting knob (called the *rostellum*) is the base of a single stamen.
- (d) The stamen is on or over the pistil.

5. The insertion of the pencil illustrates the operation unconsciously performed by insects visiting these flowers for the nectar secreted in the spurs. It is another remarkable adaptation to



secure cross fertilization. In some of the family, however, self-fertilization seems to be provided for. (*See Darwin.*)

6. Examine the ovary. Make a transverse section:—

(a) The ovary is inferior and one-celled.

(b) The ovules are numerous, and attached to the walls in three places.

(c) The ovary is therefore syncarpous, and of three carpels.

(It may be pointed out here, that this kind of placentation, *walled* as we have called it in the violet and gooseberry, is known to botanists as *parietal*, a word having the same meaning.)

7. The fruit is a capsule.

### FAMILY.

1. The floral formula is:—

$$\{K_3, C_3\}, \{A_1, G_{(3)}\},$$

in which we show that calyx and corolla are united as well as stamen and pistil.

(a) The parallel-veined leaves, and the threes in the flower, tell us the plant is a MONOCOTYLEDON. (*Refer to Table.*)

(b) Not having a perianth of chaffy bracts, fixes it in the division  
PETALOID.

(c) Of the two sections in this division, it belongs to the one having petal-like leaves, and the sub-division characterized by an  
INFERIOR OVARY.

(d) Hence it must belong to one of the five families in the third column, and this we at once determine to be the

ORCHID FAMILY.

2. This family includes some of the most remarkable flowers in the world. Some of the foreign plants are known as “air-plants;” they grow on trunks of trees, without being parasites.

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## LESSON X.

## BOTANICAL NAMES.

(GENERA AND SPECIES.)

## COMMON NAMES.

1. Many of our native plants have common names by which they are known to people who take an interest in them; and these names are generally easy to remember. But all plants have what are called botanical or scientific names; these are usually longer, and are either made from Latin words or are in the form of Latin words. Now why should such words be preferred as names, rather than the simple common ones?

2. You know the common ivy, but not the ground ivy, and you will probably expect to find the latter very much like the former. In one character only, however, does it resemble it; and that is in having running stems. The ground ivy runs along the ground, but it has no rootlets like its namesake, and the two are actually no more related to one another than this, that they are both dicotyledons.

3. Take the celandines. The greater celandine belongs to the poppy family, but the lesser celandine to that of the buttercups.

The dead nettle belongs to a family of *gamopetals*, but the true nettle to a family of the *incomplete* division.

The rock-rose is no relative of the roses so well known, nor the water violet of the violet and pansy.

The white bryony is a dicotyledon, the black bryony a monocotyledon.

4. Many more examples might be given, but enough has been said to show that common names are often misleading; they convey to the mind no information about the plants for which they stand unless we happen to know them, any more than the name John does about a boy who happens to have that name.

The fact is, the names were given by people who only took a general impression, and did not closely observe all the characters of the plant to which they were giving the name.

### SPECIES.

1. Now all those plants to which one name is given are *generally* alike; for instance, all plants called wallflower have flowers of the same shape (though not always of the same colour), leaves of the same shape, and are generally so much alike in appearance that one plant cannot be distinguished from another; the young plants grown from the seeds are exactly like their parents.

2. Take the dog rose. All dog roses are alike, in leaves, stems, prickles, flowers, and fruit. There may be slight differences, but these are not permanent; that is to say, one plant may have some little difference from other dog roses, but its seedlings will probably show no such difference.

3. A group of plants like each of these, which have permanent characters, and are so much alike as scarcely to admit of division into groups, is said to form a *species*. Thus the dog rose is a species of rose and the wallflower constitutes a species.

All plants in a species would seem to have descended at no very remote time from one ancestor.

### GENERA.

1. The field rose forms another species, and the downy rose still another, always distinguishable from one another and from the dog rose. Besides these, there are many species of roses, all comprised within the rose family, but not making up the entire family.

2. The strawberry belongs to the rose family; as does also the silverweed, the apple, the plum, and the pear. Now each of these includes one or more species, so that the family consists of several *groups* of species; and to each of such groups the name *genus* is given. This is a Latin word, and its plural is *genera*.



## LESSON XI.

## BOTANICAL NAMES.

(CONTINUED.)

## HOW BOTANICAL NAMES ARE APPLIED.

1. Now we shall be able to see how Botanical names are given and the value of such names.

2. There are several species of buttercups; one with a running stem; one with an upright stem and a bulbous root; one with narrow lanceolate leaves (the others having much divided ones); and one having white flowers and growing in water. To all these the name *Ranunculus* is applied, a word meaning a little frog. Having given that name to these different species to distinguish them from other species that belong to the buttercup family, such as the marsh marigold, which is not called *ranunculus* but *caltha*, we might describe each of the species we have enumerated as:—the creeping *ranunculus*, the bulbous, the narrow-leaved, and the water *ranunculus* respectively.

3. In effect we really do so, but use a Latinised name thus:—

*Ranunculus repens*,

*Ranunculus bulbosus*, etc.,

placing the qualifying or distinguishing word last, just as we sometimes say Smith John, instead of the more common way, John Smith.

4. To go back to our roses now, we give the name *rosa* to the whole genus, and the species are distinguished as follows:—

Dog rose—*Rosa canina*.

Field rose—*Rosa arvensis*.

Downy rose—*Rosa villosa*.

5. Every botanical name therefore tells us not only the name of the species, but also the genus to which each plant belongs. The subject of our last lesson, the spotted orchis, is called *orchis maculata*, the latter word meaning *spotted*. The wood anemone

figured in the frontispiece, is called *anemone nemorosa*. *Anemone* means *wind flower*, and *nemorosa* means *belonging to the woods*, because the plant always grows in such places.

6. This method of giving every plant a double name we owe to Linnæus, who was the inventor of the system.

### SUMMARY.

1. Every group of plants resembling each other in all their constant characters makes up a species.

2. Related species are grouped together into genera.

3. Every family includes one or more genera, and every genus one or more species.

4. A botanical name gives both the genus and species of the plant to which it is applied, and so conveys some notion of its relation.

Compare *hottonia palustris*, the water violet, with *viola canina*, the dog violet.

(It may be pointed out that the same method of naming is used in the animal kingdom, for instance, the lion and cat are but different species of one genus, the former being called *Felis leo*, and the latter *Felis domesticus*.)

5. Bentham and Hooker's "Flora" gives 89 families of Seed plants, and these comprise about 1,240 British species.

### EXERCISES.

Have schedule forms prepared like the one used in Lesson VIII., and examine fully any plants obtainable. With the aid of the Tables ascertain the family of each and record it. If a FLORA is available, find out the plant's name, that is, its genus and species.

It will greatly add to the interest of the work if good specimens, after being examined, are carefully dried between layers of dry newspapers, as directed in the note to Section II., and mounted on neat papers of uniform size. At least one representative of each family might be preserved. A number should be entered on each schedule and on the drying specimen. Beware of insects getting into the dried plants. Naphthaline or camphor will keep them away. Succulent plants and heathers require dipping into boiling water before putting into pres°

## APPENDIX.

---

### QUESTIONS.

*The following questions are intended to encourage observation. They are not taken from examination papers.*

1. What is the difference between "seed potatoes" and potato seed?
2. Observe the following trees if they grow in your neighbourhood, and estimate the height of one well-grown tree of each kind: oak, sycamore, beech, birch, pine, ash, elder. Try to obtain the correct height by means of shadows. For instance, if a 3 ft. stick cast a shadow of 1 ft., what must be the height of a tree that casts a shadow of 20 feet?
3. Which of the trees named in the last question give the most dense shade?
4. Name all the plants you can find growing under the trees in a wood. Which are most common?
5. Notice any cornfield you know and count how many wild plants grow amongst the corn. Write down the names of as many as you can.
6. Name all the kinds of grain cultivated in your neighbourhood and say at what time of the year each is sown.
7. What is meant by root crops? Name all the kinds you have seen.
8. Examine any potato or turnip field and count how many kinds of weeds grow in it. Give the names of as many as you can.
9. What are weeds? Name any you know that have attractive flowers.
10. How many plants do you know that have unattractive flowers? Write down their names.
11. Name all the plants you know that produce catkins. When do they open their flowers?
12. Where would you look to find anemones? From what kind of stem do the leaves grow?



13. Write an account of the life of a coltsfoot.
14. Ploughed fields are sometimes seen covered with yellow-flowered plants. Describe the flowers.
15. Examine a small patch of pasture land. Write down the names of the various plants growing there, as far as you can, and count how many kinds there are.
16. What plants have you seen growing in marshy land that are not found in the dry land near?
17. Name any plants you can find growing (a) entirely in water; (b) partly in water.
18. What kind of seeds has a birch tree? How are they scattered?
19. Describe the seeds of a willow. At what time of the year are they dispersed?
20. Name any plants you find that ripen their seeds in June.
21. What plants have you seen growing on a hill top or a sandy bank?
22. Plants with small yellow flowers like pea-flowers are often found on sunny banks. Get some of these and carefully describe the plant, its flowers, and its fruit.
23. Why do some plants have red berries? Name all the plants you can find that have such berries.
24. What are the chief hedge-row plants in your neighbourhood? Why do you think they are used?
25. Why are plants in hedge-rows frequently trimmed? When is the trimming usually done?
26. Observe and explain how young grass plants grow and spread out into large patches.
27. Name all the plants you know that are grown from bulbs.
28. Describe the whole life of a daffodil as if told in its own words.
29. Why can hyacinths be grown in water only?
30. Grow some sunflower seeds and keep a record of their growth until the time of flowering. The record should show the amount of growth day by day and in what parts of the stem the lengthening takes place. Then calculate the average rate.
31. What is a composite? Give a list of those growing in your neighbourhood.
32. Compare a daisy flower with a buttercup.
33. How are seeds dispersed in the following: thistles, burdock, ragwort, elm, beech, and hawkweed.

34. Why do plants need to get their leaves into sunlight? Give examples of the different ways in which this is effected?
35. How do we know that plants lose water from their leaves?  
By what means is too great a loss prevented in certain cases?
36. Why do the leaves fall from certain trees in autumn? Name the trees in your neighbourhood that do not lose their leaves at that time. When does the holly lose its leaves?
37. What is meant by "resting" buds? Describe the resting buds of beech.
38. In what respects does a root differ from a stem? What is peculiar about the stems or roots of the following: strawberry, coltsfoot, iris, turnip, carrot, potato, and scarlet runner?
39. Show that a bulb is a modified form of bud. Of what advantage is it to a plant to have bulbs?
40. Of what advantage is it to a plant to have underground stems?
41. Name any plants you have noticed that open their flowers in the evening. Can you see any reason why they should do so?
42. What is meant by saying that a plant is an annual? If weeds are annuals what is the best way to clear them out of a garden?
43. Often when a garden has been well cleared of weeds, plants of the same kind may be found growing in the following year. To what causes may this be due?
44. Examine some fruits of the ash. Take out the seed, cut it longitudinally. What do you find within?
45. Take some apple pips and peas. Soak them and take off the skins. Describe what is found within. Grow some in a pot and describe how they appear above the soil. In what respects do they differ?
46. From which end of the acorn does the young plant grow out? Which part emerges first, root or stem?
47. Place some date "stones" in a moist, sandy soil and keep them warm. Notice how long they take to germinate, and describe the appearance of the plant produced.
48. Describe the bluebell and show in what respects it differs from the harebell, both as regards the form of the plant and the structure of the flower.



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